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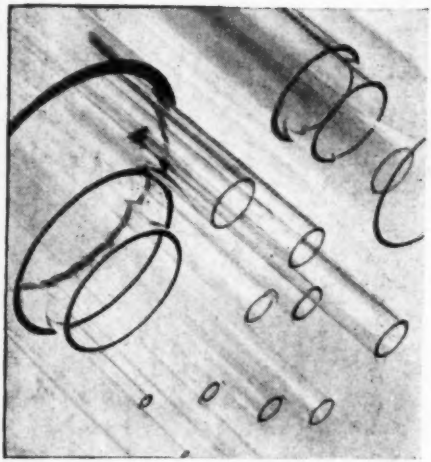

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Current Science

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CONTENTS

Letters to the Editor

TECTONIC PATTERN OF INDIA

DR. M. S. KRISHNAN

THE knowledge gradually being accumulated about the crust of the earth indicates the existence of a general pattern which controls the form and evolution of the earth. The land masses are built around certain areas of great stability known as *shields* and *platforms*. There are several systems of folded mountains which traverse the land masses and these are of three or four distinct geological ages. The latest of these ranges, which belong to the Cainozoic age, are responsible for the present configuration of land and sea, though they have been very largely influenced by previous mountain building movements which took place in the Silurian (Caledonian Orogeny), Carboniferous (Variscan) and Jurassic (Cimmerian or Nevadan). The Cainozoic mountains referred to above form two world encircling girdles, one set completely surrounding the Pacific Ocean and the other branching off from it at right angles in Indonesia and following the Indonesian-Himalayan-Alpine belt. These mountain arcs are convex towards, and are thrust over, the Pacific Ocean in the first set while the second group are thrust over or towards the fragments of Gondwanaland (Australia, India and Africa). In the first set, the arcs are very clear and orogenic activity is still going on while in the second the meeting of Gondwanaland with Laurasia has brought the movements to a stop, presumably in very recent geological times.

There are two types of ocean basins. To the first type belongs the Pacific Ocean which is deep and shows basaltic rocks (Sima) at its bottom except for a small thickness of 0·5 to 1·5 km. of sediments. It is cut up into a few major fault-blocks which are at different levels, the edges of these blocks being marked by terrace-like scarps. The ocean bottom contains only 5·0 to 7·0 km. thickness of basaltic rocks, below which comes the Mohorovicic discontinuity.

The Atlantic and Indian Oceans, which form the second type, are shallower in depth (about 4·5 km. against 5·5 km. in the Pacific Ocean) and they contain a thickness of about 2 km. of sial at the bottom, above the basaltic basement. The Mohorovicic is also somewhat deeper, by 3 to 5 km., than in the Pacific Ocean. These oceans are bordered by lands whose coasts show well-marked fault features, the structures on the land often terminating abruptly at the coast. Along the middle of these oceans are broad ridges whose tops may rise above sea-level as volcanic islands. The bases of these ridges are a few thousand kilometers broad, while the flanks show a series of nearly parallel ridges, all composed of basaltic rocks. The central portion, probably throughout their whole length, is occupied by a deep rift along which volcanic and seismic activity is prominent. These mid-ocean ridges appear to owe their origin to the extrusion of lava through more or less parallel fissures along a zone in the middle of these oceans, which was abnormally stretched by the

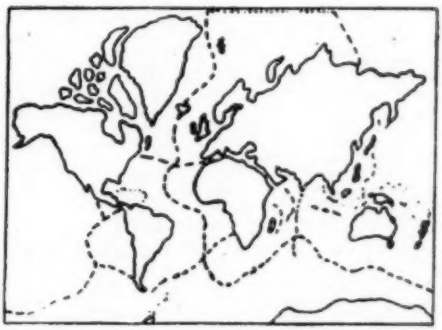

FIG. 1. Mid-ocean rift system.

drifting away of continental masses on either side. The parallelism of the mid-ocean ridges (particularly mid-Atlantic ridge) to the coasts on either side has obviously some significance with reference to their origin and mode of formation. The ridge system is world-wide as it can be traced along the whole of the Atlantic basin across Iceland and the Arctic Ocean to the mouths of the Lena in Siberia; in the south it joins the mid-Indian Ocean ridge in the region of Crozet and Kerguelen islands. The mid-Indian Ocean ridge becomes the Carlsberg ridge in the Arabian Sea and merges into the Red Sea rift between Africa and Arabia. At the southern end, the same ridge can be traced into the Pacific where it goes into the Albatross Plateau, Eastern Island and the Galapagos. The Cainozoic mountain system and the mid-ocean ridge system appear to be complementary features, the first being due to compression in the crust and the other due to tension. In the one, sialic matter has been piled up with folding

and overthrusting, with the accompanying depression of the Mohorovicic to a depth of 40 to 60 km.; in the other, simatic matter has come up through fissures in the stretched and torn crust to the surface in an effort to establish equilibrium when the sialic continental mass originally covering it had slipped off and brought about the stretching of the attenuated crust at the ocean bottom.

India is considered to have been part of a former land mass called Gondwanaland, which comprised all the present southern continents, as will be seen from the close relationship of their late Paleozoic and Mesozoic geology. The Peninsular part of India is a stable shield which has remained practically unchanged since the Pre-Cambrian times. It is dominated by a tri-

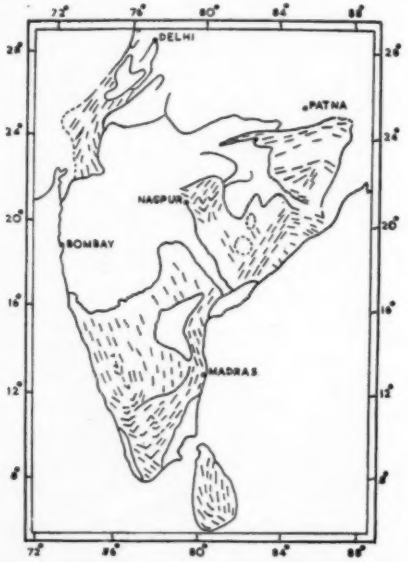

FIG. 2. Structural trend lines in Peninsular India.

angular structural pattern. The Aravalli mountains and the Eastern Ghats, in the north-west and south-east respectively, have a N.E.-S.W. trend. The Dharwarian formations in Southern Bombay and Mysore have a N.N.W.-S.S.E. direction; the Satpuras, south of the Ganges valley, have a E.N.E.-W.S.W. trend. The Eastern Ghats trend turns to the east near the Mahanadi valley and strikes out to the sea. There seems to be a N.W.-S.E. trend in the hinterland of the Eastern Ghats, though data are meagre for that region. In the southernmost part of India the Eastern Ghats province seems to spread out including also Ceylon. It is not known whether one or two 'nuclei' are present in the central part of India around which these structures have developed. The only other formations in the Peninsula are the Cuddapah and Vindhyan systems which had been laid down in epi-continental basins, the Cretaceous and Cainozoic which form narrow coastal fringes, and the Deccan Trap lava flows. These have scarcely any influence on the structure of the Peninsula.

All along its northern borders, India is covered by arc-shaped mountain ranges, built out of thick sediments deposited in a huge geosyncline which occupied during the whole of the Mesozoic era a wide east-west belt including the area now occupied by India. The arc of the Himalayan mountains makes a broad sweep from Nangaparbat on the north-west to the Sikang-Burma border on the north-east. The Burma arc commences from the latter region and proceeds through Arakan, Andaman and Nicobar islands into Indonesian Archipelago. This arc is also of large diameter with convexity towards India, with only a slight concavity in the Arakan region. The Baluchistan arc on the north-west is, however, cut up into three (or even four), festoons the point of convergence of the strata being near Dera Ismail Khan and Quetta. The southernmost festoon comprises Khirthar and Mekran ranges and spreads into Oman in Arabia and into Southern Iran where it merges into the Zagros mountain ranges.

The two sharp hair-pin bends, both structural and stratigraphic, in north-west Kashmir and beyond the north-east corner of Assam, are thought to be due to wedge-like projections of Peninsular India into the respective regions. The minor wedges are responsible for the festoons in the Baluchistan arc. These features are to be interpreted as originating from the drifting or sliding of the continental mass of India from its original position far to the south, to its present position in the Tethyan geosyncline, compressing sediments of this geosyncline into huge mountain ranges which were thrust over the borders of the shield from the N., N.E. and N.W. It is obvious that the movement of the single mass of India with its wedge-like projections could produce simultaneous thrusting and overflow of sediments of the Tethyan basin towards and over the borders of India. On the eastern and western sides, that is in Indonesia and Mekran, the compression was far less but strong enough to produce an island arc on the eastern side and a series of parallel folded ranges on the western side, the over-folding in both the cases being towards the south.

The northward movement of India produced not only the Himalayan mountain system but also helped to compress further the several parallel ranges in the north including the Ladakh, Kailas, Trans-Himalaya, Alinkangri, Karakorum-Thangla, Kun Lun, Altyn Tagh, Trans-Alai, Tsin Lin and Nan Shan ranges, some of the latter ranges being of an earlier age (Hercynian or Cimmerian) but finally uplifted during the Himalayan Orogeny. The compression of the sediments of the Tethyan basin was the result of the drift of India to its present position as indicated by the great distortion of that basin. The close resemblance of the geology of the southernmost part of India and Ceylon to that of Madagascar and East Africa lends much support to the idea that India lay alongside Africa with Madagascar in between but attached to the south-west part of India. The east coast of Madagascar is a very clearly demarcated and straight fault line, along which Lower Cretaceous strata are found as the earliest sediments thereon. It is agreed by all who support the hypothesis of continental drift that Gondwanaland broke up in the early Cretaceous and that Madagascar moved to the south-east with reference to Africa and that India moved northward with reference to Madagascar. The drifting or sliding of the continental mass of India produced tension phenomena in East Africa and in the Arabian Sea. The westernmost of these features is the system of East African rift valleys which trend North-South, having conjugate fractures in the north-east and north-west directions. Though they are considered as ancient structural features, they probably took their shape gradually as a result of tension in the crust at various times from the Triassic or early Jurassic when the Mozambique channel separated Madagascar from Africa. Concentric with Madagascar and the submerged platform on which it stands, there are two ridges. The first is the one on which the islands Amirante-Seychelles-Cardagos-Mauritius-Reunion are situated. The second is the well-known Carlsberg ridge which is a feature continuous with the

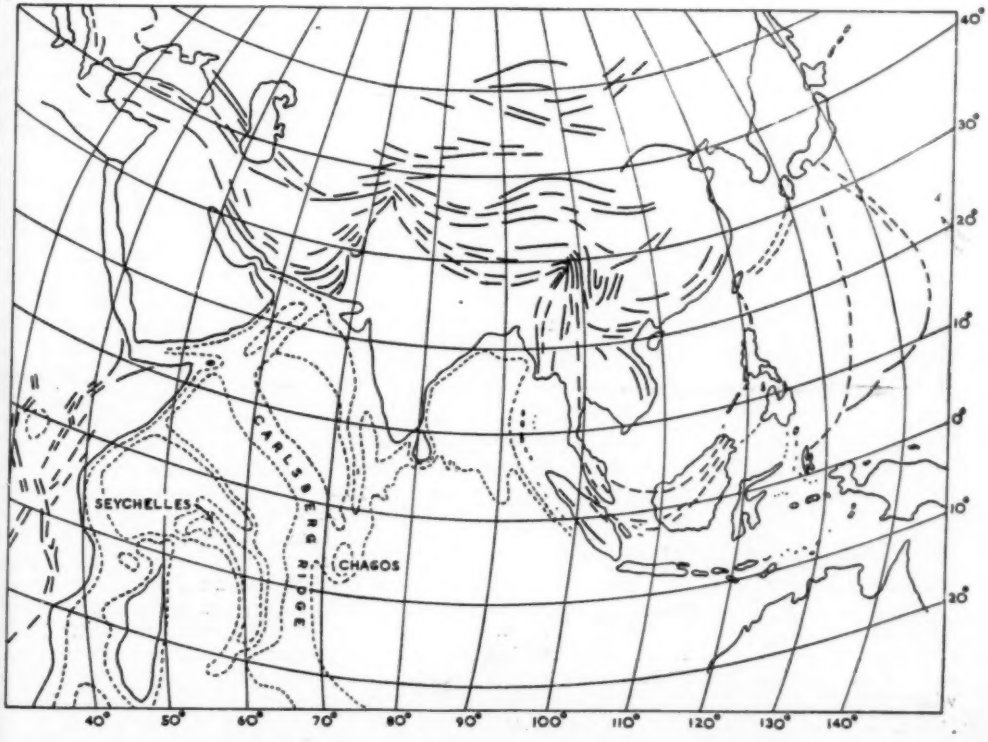

FIG 3. Mountain ranges of Southern Asia and the rift and ridge system of the Indian Ocean.

Red Sea rift on one side and with the mid-Indian Ocean ridge on the other. The Red Sea is known to have been formed at the end of the Eocene or early in the Oligocene, which can be correlated with the Upper Eocene phase of Himalayan Orogeny. Finally there is the late Pliocene or Pleistocene faulting of the Mekran-Persian Gulf region which was more or less contemporaneous with the last phase of Himalayan uplift. The movement of Arabia must have been halted by this time as indicated by the separation of the Mekran region from the adjacent Oman region. The same periods of mountain building, *viz.*, Miocene or early Pleistocene, are also well recognised in the Indonesian islands, so that it is possible to correlate these phenomena with the general crustal movements connected with the Alpine-Himalayan Orogeny. There are also connected evidences of tension in the crust as indicated by the great fissure-eruptions of the Deccan trap lavas in India and in Somaliland and Ethiopia during Laramide and early Eocene times.

It will be seen that the Tethyan basin which occupied Central and Southern Asia was subjected to tremendous compression between Laurasia and India. The average elevation of land in this region is 12,000 to 13,000 ft., and the mountain ranges are several thousand feet higher. This abnormal accumulation of sial is reflected in the high negative gravity anomalies ranging from 250 to 560 milligals, along the various ranges mentioned above, the largest being along the axis of the Kun Lun mountains. This exceptional deficiency in gravity must necessarily initiate some action by which equilibrium can ultimately be attained. This can happen partly by the rapid surface erosion and transport of material from Central Asia to the oceans and also partly by sub-crustal migration of sialic and simatic matter. That the latter is actually in progress is shown by the development of the great island arcs along the east and south-east coast of Asia and by the overthrust of continental masses over the Pacific and Indian Oceans in the respective sectors.

The seismicity along the northern borders of India is an expression of the great instability of the region. Shallow earthquakes occur all along the mountain belt as well as along the tensional features in the Arabian Sea, Red Sea and the East African rift system. The regions where wedges of the Indian continent are projecting into the Tethyan belt are particularly active regions, as apparently they are subjected to much greater stresses than elsewhere. Two of these, namely, the Pamir region at the head of the Punjab-Kashmir wedge and the S.W. China region at the head of the Assam wedge are characterised by frequent large earthquakes; in the former area earthquakes occur repeatedly at intermediate depths of 220 to 230 km. indicating that the disturbance extends to such depths. Detailed data are not available regarding the north-eastern area.

The northern border of the Indian continent was warped down during the drift and thrust under the Tethyan sediments, which were thereby enabled to advance over them from the north. This border region forms the *fore-deep* along which Indus, Ganges and Brahmaputra rivers are now flowing. This region must originally have been covered by a series of lagoons during the Pliocene and Pleistocene periods which were gradually filled by sediments by the end of the Pleistocene Ice age. This depression is known to contain over 20,000 ft. of sediments about half of which is probably of Tertiary and Pleistocene age, the maximum thickness being near the foot of the mountains.

It is suggested that as a result of the drifting of India from a position far to the south in the Indian Ocean, a series of structures have been developed which are closely related. The tensional fractures which developed in the north-western part of Indian Ocean may be correlated with the various stages in the compression and uplift of the Himalaya mountains and the other ranges to its north in Central Asia. At the same time, the great accumulation of light sediments and other rocks in Central Asia has necessitated the redistribution of some of this material by sub-surface transfer which manifests itself as active island arcs along the borders of East and South-East Asia. The outermost of these arcs are of very recent geological age and there are reasons to believe that movements are still going on. It may be added here that the Arctic Ocean is also opening out so that the Pacific basin is being encroached upon from all sides by continental masses. Thus mountain building in Central Asia, the formation of tension rifts and ridges in the north-western Indian Ocean and of island arcs in the Pacific are all manifestations of the same forces in the earth's crust during the comparatively limited time of the Cainozoic era in the earth's history.

APPLICATIONS OF NUCLEAR MAGNETIC RESONANCE AND HIGH RESOLUTION RADIO-FREQUENCY SPECTROSCOPY

S. S. DHARMATTI

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1. Introduction

THE discovery of the tuning in of the spinning nuclei of atoms in magnetic fields was announced, as early as in 1946, simultaneously by Felix Bloch of Stanford University and Edward Purcell of the Harvard University who used rather different techniques—one being of induction type and the other of absorption. Within a short period the subject grew with no bounds and like many other discoveries of physics spread into distinctly separate fields of research, such as, chemistry, metallurgy, geology and even biology. It was not surprising that the Nobel Prize was awarded to this discovery in 1952 just after 6 years of its first announcement—a recognition of the importance of the subject even before it unfolded all its potentialities. An earlier article on the subject in this journal (*Curr. Sci.*, 1959, **28**, 183), dealt chiefly with the principles of nuclear magnetic resonance (n.m.r.) and in the present article it is proposed to lay emphasis on some of the more important applications of this versatile technique.

The n.m.r. method mainly depends on the fact that many isotopes display a finite nuclear magnetism and possess a gyromagnetic ratio γ, given by,

$$\gamma = \frac{\mu}{I\hbar},$$

where

$$\hbar = \frac{h}{2\pi}.$$

By nature these gyromagnetic ratios are such that for no two nuclei they are identical. Hence it is possible to label each nucleus with a definite value of γ and the n.m.r. method can then distinguish between isotopes by their differing gyromagnetic ratios. It has been shown in the previous article (*loc. cit.*) that the precession frequency (ν) is given by the relation,

$$\omega = 2\pi\nu = \gamma H,$$

and can be measured very accurately in a given magnetic field. This enables one to calculate γ for a nucleus.

2. Nuclear Magnetic Moments and Nuclear Spins

The use of this phenomenon, immediately after its discovery, was made for the accurate determination of the nuclear magnetic moments and spins of several stable isotopes with spin number $I > 0$. It is obvious from the n.m.r. condition mentioned above that

$$\nu = \frac{\gamma H}{2\pi} = \frac{\mu}{Ih} \cdot H.$$

This relation can be used to determine the magnetic moment μ of a nucleus (whose spin number I is known) by measuring its magnetic resonance frequency in a given field H. It must be noted here that the radio-frequency ν can be measured with an absolute accuracy of one part in 10^6 or even better. However, there are difficulties in measuring the magnetic field H to the same accuracy. The Planck's constant h is known to an accuracy of the order of one part in 10^4. It is, therefore, considered advisable to compare experimentally the resonance frequencies of two nuclei of known I in the same magnetic field H. Then using the relation

$$\frac{\gamma_n}{\gamma_{un}} = \frac{\mu_n}{\mu_{un}} \cdot \frac{I_{un}}{I_n},$$

the unknown magnetic moment μ_{un} can be determined by selecting a reference nucleus whose magnetic moment μ_n has been very accurately determined earlier by precision methods. Usually proton has been used as a reference nucleus since its μ has been measured precisely to a desirable accuracy.

One special feature of the nuclear induction method or the Bloch or cross-coil technique is that it can determine the sign of the nuclear magnetic moment. The phase of the nuclear induction signal relative to the leakage signal depends on the sign of the nuclear magnetic moment. Under identical leakage conditions, the signal traces of the reference and the other nucleus, the sign of whose magnetic moment is to be determined, can be compared. In this way the signs of several nuclear magnetic moments have been either determined or confirmed.

A suitable expression can be derived for the n.m.r. signal strength involving the spin number I, the gyromagnetic ratio and other quantities which can easily be evaluated. This expression can then be used to compare the signal strengths since the ratio of γs can be obtained by the ratio of frequencies at which the two resonances are observed in the same field H. It is then

possible to determine the spin number for a nucleus from the known spin number of the nucleus chosen for comparison. There are other methods too, such as the measurement of absolute signal strength, electric quadrupole splitting and the fine structure of the resonance line. However, it is very convenient to find an unknown spin number by comparing the signal strengths as mentioned above.

Thus the n.m.r. technique has helped considerably in obtaining the nuclear properties such as the precise measurements of magnetic moments, their signs and the spin number which are essential data needed for the elucidation of the nuclear structure, the most vexed problem of the day.

3. Nuclear Relaxation Phenomena

The n.m.r. technique has been successfully utilised for the study of nuclear relaxation phenomena. Through the observation of the nuclear magnetic resonances, it is possible to study the details of molecular motions even in complex systems. For this purpose one distinguishes between two relaxation times—one called the spin lattice or longitudinal relaxation time T_1 which has something to do with the establishment of thermal equilibrium between nuclear spins and their surroundings. The coupling mechanism depends upon the nature and properties of the system and the nucleus. For instance, lattice vibration may be a dominant factor in pure solids, large electronic magnetic moment in solids impregnated with paramagnetic impurities, random Brownian motions in liquids and gases, and interaction of unpaired conduction electrons near the top of Fermi band with nuclear moments in metals. The measurement of T_1 by n.m.r. technique has thrown sufficient light on some of the mechanisms so far proposed.

A second relaxation time T_2, often called the spin-spin or transverse relaxation time, plays an equally important role in the n.m.r. phenomena. It describes the processes by which the nuclei in a given system tend to lose their phase coherence and thereby bring about changes in the strength of a precessing macroscopic magnetic moment vector of the nuclear spins. Several factors have been proposed, which contribute to the transverse relaxation, such as the intrinsic nature of the sample, homogeneity of the applied magnetic field, non-homogeneous magnetic fields within the sample, viscous media, dipole-dipole interactions or spin-spin collisions. The measurement of T_2 by n.m.r. technique has provided a means of understanding these various processes. Both T_1 and T_2 are vitally important in understanding the character of the nuclear resonance signals and several workers have been busy in the measurement of these relaxation times.

4. Chemical Shift

In the n.m.r. technique, all magnetic nuclei should obey the fundamental resonance condition $\omega = \gamma H$. However, one should not forget the facts that the nuclei used in n.m.r. experiments are embedded in bulk samples such as solid, liquid or even gas at high pressure. In these varied samples of different phases there are likely to be internal molecular magnetic fields and on application of steady external magnetic field an induced internal magnetic field can also arise. In terms of these effects, it is necessary to modify the above fundamental n.m.r. condition as

$$\omega = \gamma\,(H_{ex} + H_{local}) = \gamma H_{ex}\left(1 + \frac{H_{local}}{H_{ex}}\right),$$

or

$$\omega = \gamma H_{ex}\,(1 + \sigma)$$

where H_{ex} is the externally applied steady field, and σ is usually defined as the internal electron distribution susceptibility. This improved resonance condition clearly indicates a shift in the resonance field or the frequency, the magnitude of which depends on the local field produced at the nucleus by the internal electron distribution in the sample. These shifts in the resonance field or frequency are called 'chemical shifts' and are often extremely small in comparison with the applied steady field, say, a few parts in 10^6 or more in some cases. For instance, the shift in methyl alcohol for protons is of the order of 16 milligauss in 10 kilogauss. The chemical shifts are field-dependent, and obviously, to observe these very small but significant shifts in nuclear magnetic resonance spectrometer, the steady magnetic field should be extremely homogeneous, say 1 part in 10^6 or even more; the stability of both the magnetic field and the frequency of the oscillator producing the transverse oscillating field H_1 should be very high.

The chemical shifts are conveniently measured by the n.m.r. technique with respect to an external standard, preferably in coaxial tubes, one containing the standard and the other the substance under investigation. The chemical shift parameter δ is usually expressed as

$$\delta = \frac{H_{sample} - H_{standard}}{H_{standard}}$$

where H_{sample} is the observed resonance field for the sample under investigation and $H_{standard}$ that for the standard sample.

The chemical shift parameter δ is generally a function of electron density around the nucleus in question since the electrons are involved in the diamagnetic shielding. Attempts have also been made to correlate δ with electronegativities as electronegativity is related to electron density. Some investigators have tried to establish a relation between δ and the Hammetts' constants σ for compounds in which a substituent is located in a *para* or *meta* position. But the situation is not quite so simple as one expects. Ramsey has developed a general theory for the magnetic shielding of nuclei in molecules and has shown that there is a contribution of both diamagnetic and paramagnetic terms. This theory of Ramsey has been simplified further by Saika and Slichter who have introduced three terms: (i) the diamagnetic contribution from electrons associated with atoms in question; (ii) the paramagnetic contribution from the orbital motions of the valence electrons and (iii) the contributions from other atoms. This theory has been able to explain qualitatively the correlation of chemical shifts with ionic character in many fluorine compounds. Although it is difficult in general to calculate an accurate theoretical value, it cannot be denied that the shift has something to do with the nature of the chemical binding in the atom. The chemists have, therefore, always made attempts in their own way in correlating the observed shifts with the electronic structures of molecules and the nature of the chemical binding.

In some cases the chemical shifts are extremely high, of the order of 1·5%. They are attributed to the effect of mixing of the ground and low-lying excited states of electrons as in the case of UF_6 for which the second order paramagnetic term is nearly twice as large as that for F_2. Considerable amount of work in this connection has been done with respect to cobalt complexes where such low-lying states are expected and the shifts obtained are of the order 100 gauss in 10 kilogauss. Recently, Orgel has worked out the 'Ligand Field' theory which seems to fit well with nuclear magnetic resonance shifts observed in our laboratory in solutions of cobalt complexes.

The chemical shifts are of great aid in the investigation of structural problems involving nuclei in different locations. When several identical nuclei are embedded in a molecule but in different electronic environments, it is obvious that each group of identical nuclei has a different chemical shift and consequently a different resonant frequency. In such a case in an extremely homogeneous magnetic field and with a liquid specimen the n.m.r. should show a fine structure. The well-known examples are the methyl and ethyl alcohols where the peaks of proton resonance in CH_3, CH_2 and OH are well separated out and the areas under the peak stand roughly in the ratio 3 : 2 : 1, as is expected if each peak corresponded to the chemically different CH_3, CH_2 and OH protons. Thus the n.m.r. spectrum becomes the finger-print of the molecules identifying the exact locations of the nuclei in a molecule. Structures of several organic compounds have been studied in this way and the n.m.r. technique has thus become a powerful tool in the hands of chemist for the structural study, identification and chemical analysis.

5. N.M.R. Shifts in Metals

The n.m.r. shift of any nucleus observed in a metal occurs at considerably lower fields than in compounds for a fixed frequency. This is called the "Knight shift" and has been attributed to the paramagnetism of conduction electrons since the shifts are too large to be accounted for by a simple difference in magnetic susceptibility of the materials, or by differences in the diamagnetic correction for the metallic and non-metallic atoms. Korringa has shown theoretically that Knight shifts and the spin lattice relaxation time T_1 are interdependent. Knight shifts have also been measured in several metals over temperature ranges and the results do not support the assumption of an appreciable degree of electron and lattice interaction. There are several phenomena of metallic state which need sensitive checks on the validity of wave functions proposed for conduction electrons and the nuclear magnetic resonance shifts may prove fruitful in resolving some of these problems.

6. Multiplet Structures in N.M.R. Spectra

Subsequent to the discovery of the chemical shift, while working with spin-echo experiments Hahn and Maxwell discovered the existence of two parameters, one field dependent and the other field independent. The chemical shift is the field-dependent parameter while the field-independent one is called the spin-spin interaction, and was then explained by introducing a rotationally invariant interaction between nuclear spins. The spin-spin interaction is a sort of indirect coupling of the nuclei through the electrons and is responsible for the

multiplet structure observed in the resonance. The fine structure is also independent of temperature and the splittings are of the order of 10^{-3} gauss to 2 gauss, much smaller than the chemical shifts. Since the effect is due to the coupling of non-equivalent sets of magnetic nuclei by the bonding electrons, the intensity of the split components depends on the statistical weights of the different spin combinations. The number of components in the splitting or the multiplet are equal to $2nI+1$, where n is the number of equivalent nuclei which split the resonance and I the spin number. Such splittings have been observed by n.m.r. technique and the number of components have been verified.

The line widths in such structures are of the order of a few cycles/sec. To obtain a spectrum of this nature, the n.m.r. spectrometer needs a high resolution and much more so in a complex spectra where the chemical shift is superimposed by the spin-spin interactions. A resolution of the order of 1 in 10^8 or at least 10^7 is expected for the study of such spectra where it is possible to distinguish the chemical shift from the spin-spin interaction by the field dependence of the former.

7. Experimental Arrangements

One has now to ask the question as to what are the essential features of a high resolution spectrometer. The field homogeneity of the magnet in this spectrometer should be of the order of 1 in 10^8. The magnet may be a permanent one or an electromagnet. Electromagnets are used for this purpose and the current and the voltage are both regulated and stabilized in order to maintain the desired high stability. The field is locked up by a proton signal or by a superstabilizer. A superstabilizer consists of two electronically controlled coils put on the large pole-pieces of the magnet. One of the coils senses even the small changes in the magnetic field and the other one corrects it. Sometimes the magnets are well shimmed for higher homogeneity. A permanent magnet can also be used which certainly does not need the current or voltage stabilizer, but its pole-pieces must be extremely polished and aligned perfectly parallel. Usually the pole-pieces are about 12" in diameter. The bigger the diameter, the better is the homogeneity at the centre. The residual inhomogeneity, if any, can also be corrected by current shimming.

In addition to the homogeneity of the magnet, the oscillator frequency has to be stable to an order of 1 in 10^8. Thermally controlled crystal oscillators are used for this purpose and the receiver should introduce as little noise as possible. The nuclear induction head which contains the sample is a tricky part of the spectrometer and the details appear in the literature.

In a high resolution spectrometer there is an arrangement to spin the sample. The inhomogeneities over the sample volume are averaged out by spinning the sample with rotational frequencies of a few hundred revolutions per minute. In this process of spinning each nucleus is carried through the entire distribution of fields in a time short compared to T_2.

The possibility of distinguishing the chemical shift by its field dependence has already been mentioned. But with a permanent magnet, field cannot be varied. Even with an electromagnet the field variation may be limited within attainable field strengths to identify the chemical shifts. Under these circumstances a new technique known as the 'double resonance' can be used with the help of which the spin-spin multiplets can be collapsed and a simplified spectrum easily amenable for interpretation can be obtained. The principle of the double resonance is to agitate the spin orientation of the interacting nuclei very frequently so that the perturbing field on the observed nuclei is averaged out. This is best done by using another oscillator and transmitting coil at right angles to the already existing transmitting coil. With the help of this, we can use a strong radio-frequency field of the right frequency to introduce transitions between the various spin states of the interacting nuclei.

8. Some Applications

The first complete analysis of the complex spectra of ethanol was made by Arnold in which the predictions of the chemical shift and spin-spin interactions were verified. The spectra clearly showed the three peaks of proton chemical shifts in OH, CH_2 and CH_3 along with the spin-spin interaction which gave three splitting components in OH and CH_3 and eight in CH_2. Later Anderson studied nuclear magnetic resonance spectra of several intricate hydrocarbons, using double resonance. This technique has been further extended by Shoolery to the interesting study of several boranes. Many other investigators have studied controversial structural problems which they have successfully solved by the application of high resolution n.m.r. spectroscopy, and this new technique is already becoming a cherished tool of the organic chemist.

This does not exhaust the chemical applications of n.m.r. spectroscopy. Reaction kinetics can be followed by measuring rates of increase or decrease of n.m.r. signals due to reactants and products. Chemical exchange rates can be studied since there is a gradual change in the appearance of n.m.r. in a particular chemical environment as the mean lifetime in that environment decreases. Proton exchange in alcohol and water mixtures and in ammonia and ammonium ion has been studied in this way. Rates of rotation around single bonds in general and the rate of inversion of non-planar nitrogen of cyclic imines have been the subject of n.m.r. investigation. Chemical analyses both qualitative and quantitative of certain isotopes containing magnetic nuclei can be easily carried out by n.m.r. method. This technique is well suited where fast analysis is desired and the sample under study if costly and rare can be preserved during the process of analysis. Deuterium in natural water has been analysed with ease and sufficient accuracy.

The radio-frequency spectroscopy is quite useful for the study of crystal structures containing light atoms which are weak scatterers of X-rays. The line shapes and widths give very important information in the crystal study. Line shapes are usually determined by the interaction between the nearest dipole neighbours. The location of the nuclei with respect to the crystal axes, in a single crystal, can be determined from the nuclear magnetic resonance line shape as a function of the crystal orientation in the magnetic field. In crystal powders the nuclear magnetic resonance line shape is determined by averaging over a sphere the angular dependence. The average line shapes are considerably broadened but still give the proton-proton distance though with less accuracy. Line shapes for three spins at corners of an equilateral triangle and four tetrahedral spin ($I = \frac{1}{2}$) have been calculated. For more general systems in which the nuclei are not localized in small groups the calculation of the line shape is a difficult task. However, Van Vleck has shown that the second moment of the n.m.r. line can be related to given structural model. This is a powerful method of determining the internuclear distance.

The technique of n.m.r. has also been used to understand the quadrupole interactions. Nuclei with $I > \frac{1}{2}$ have electric quadrupole moments and in a rigid crystal lattice, the quadrupole interactions split the magnetic resonance line. Since in a single crystal the magnetic resonance is split into $2I$ components it is posssible to determine the spin number. From the number and spacing of lines one can determine the strength of interaction e^2qQ (the coupling constant) and the asymmetry parameter η. Several boron and sodium compounds have been investigated in this way.

Nuclear magnetic resonance has even invaded the fields like geology and biology. The earth's magnetic field can be scanned with great precision by the proton precessional magnetometer, a sensitive device to measure the variations in the earth's magnetic field. Rockets shot out of the earth's atmosphere to bring in the upper air information carry this type of magnetometer to measure the intensity of the earth's magnetic field at various heights. It is also used for prospecting minerals in geological survey. In the field of biology, n.m.r. has been used to examine the water content in proteins, carbohydrates and vegetable tissues. Water-structure changes have been examined in Hemocyanin, soluble starch and egg albumin. Proton resonance study with muscle stretching has been made. Analysis of biochemicals can be made without destroying the material. Structure of giant molecules can also be investigated.

Before concluding it is fascinating to know two remarkable effects which n.m.r. can detect. Direct experimental evidence has been obtained from the n.m.r. of protons in antiferromagnetic crystals regarding the formation of sub-lattices due to the alternate arrangement of spins. X-rays would not have detected this since X-ray scattering is independent of spin. The only other way of detecting it is by neutron diffraction. Another fantastic concept is that of negative temperature. In this concise article, space does not permit to go into the details. However, it may be mentioned that the n.m.r. studies of crystals of long relaxation times have established the state of negative temperature. It is a state which, instead of being cold, is very hot and can give up energy to a system in contact with it at a positive temperature.

Although n.m.r. spectroscopy had its birth quite recently, it has already become a powerful tool in the hands of scientists belonging to different disciplines. The increasing spate of publications on the subject speaks for the popularity of the n.m.r. technique as a tool in investigating physico-chemical problems. At the present moment the cost of instrumentation of a high resolution n.m.r. spectroscope unfortunately restricts the number of incumbents in this field which impediment we may hope in the coming years may disappear.

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PROFESSOR T. R. SESHADRI: 60TH BIRTHDAY CELEBRATIONS

THE Sixtieth Birthday of Prof. T. R. Seshadri, Head of the Department of Chemistry, University of Delhi, was celebrated with *eclat* on February 3, 1960, in the Old Library Hall of the University. The large gathering included many of his old students and friends. Felicitous speeches were made on the occasion and messages of greetings were received from Sir Robert Robinson, F.R.S., N.L., and Sir C. V. Raman, F.R.S., N.L., amongst others.

Prof. Seshadri is well known for his original studies of the chemistry of naturally occurring compounds, particularly flavonoids. To mark the occasion, his past and present students brought out a souvenir which contains 21 review articles covering the different branches of the research work of Prof. Seshadri and his pupils.

We are happy to note that his 60th Birthday Celebrations have almost synchronized with his election to the Fellowship of the Royal Society.

SYMPOSIA ON 'WAVE PROPAGATION' AND 'ELECTRON DEVICES'

IN connection with the Golden Jubilee Year (1959-60) of the Indian Institute of Science, Bangalore, the Department of Electrical Communication Engineering arranged two symposia, one on "Wave Propagation" and the other on "Electron Devices". The symposia were held on November 23-25, 1959, and were inaugurated by Dr. S. Bhagavantam, Director of the Institute.

About 100 delegates representing various organisations of Government and industry, academic institutions, etc., took part in the presentation of papers and the discussions.

The Symposium on "Wave Propagation" opened with an address by Dr. K. R. Ramanathan, Director, Physical Research Laboratory, Ahmedabad, on "The Earth's Outer Atmosphere and Interplanetary Space".

There were three technical sessions under the Chairmanships respectively of Sri. P. N. Agerwala, Chief Engineer (Planning), Posts & Telegraphs, Government of India, Col. B. M. Chakravarthi, Superintendent, Electronic Research and Development Establishment, Bangalore, and Col. K. K. Mehta, Chief Inspector, Inspectorate of Electronic Equipment, Bangalore. Thirteen papers were presented and discussed in these Technical Sessions.

Sri. B. V. Baliga, Managing Director, Bharat Electronics Ltd., Bangalore, who presided over the Symposium on "Electron Devices" and was also Chairman of the first Technical Session, presented a review of "Progress in the Field of Electron Devices". The other two Technical Sessions were held under the Chairmanships of Prof. A. I. Vishnevsky, Indian Institute of Technology, Bombay, and Sri. Jagdeesh Prasad, Managing Director, Indian Telephone Industries, Bangalore. Sixteen papers were read and discussed in the Technical Sessions.

Two General Discussions were arranged one at the end of each Symposium. The first was on "The Interdependence of Research in the Physics and Engineering of Wave Propagation" and the second was on "The Impact of the Development of a New Electron Device on the Components Industry and on Communication Systems". Prof. S. V. Chandrasekhara Aiya, Head of the Department of Electrical Communication Engineering, Indian Institute of Science, Bangalore, initiated these discussions.

The symposia were a success especially as they helped in bringing together persons actively engaged in these fields in research, development planning, manufacture and maintenance. The group discussions, held outside the Technical Sessions, of selected papers evoked considerable interest and were of great value to the participants. Mr. S. Sampath, Assistant Professor of the Department, was the Convener of the Symposium.

USE OF TRACER ATOMS IN ANIMAL HUSBANDRY

PROF. V. V. KOVALSKY
Corresponding Member of the Academy of Agricultural Sciences

TRACER atoms are finding ever wider application in animal husbandry in the USSR. The method is not only becoming a permanent part of the work of research laboratories but also helps to solve practical problems on the farms.

An example of the solution of a practical problem is the determination of the conditions required to obtain fodder of full value. This is particularly important in districts where the soil is poor in minerals. Fodder plants grown in such areas contain an insufficient number of mineral nutritive elements, required to ensure the health and high productivity of livestock. In order to enrich the fodder with the necessary mineral substances special mineral fertilisers are applied to the soil.

The use of mineral fertilisers containing combinations of tracer atoms—radioactive isotopes of phosphorus-32, calcium-45, copper-64, cobalt-60, manganese-54, zinc-65, molybdenum-99, iodine-131 and other chemical elements—makes it possible to decide simply and directly in the field questions of great practical importance: *e.g.*, what part of the compounds contained in the fertiliser and required by the plant is assimilated by the latter from the soil, how effectively certain compounds of microelements (microfertilisers) introduced into the soil are utilised by the plants, which of these are best assimilated by, and are most accessible to, the plants? The method of tracer atoms is the only way of directly solving these problems.

The new branch of agrochemistry, *viz.*, isotope agrochemistry, is closely connected with the problem of feeding livestock. Livestock feeding of full value must be based not only on the data of the chemical composition of the fodder, but also on a study of the absorption of the fodder components by the digestive organs and of the metabolism in the animal organism. The chemical composition of fodder is determined by the usual chemical and spectral methods, but these cannot establish the degree of absorption. This factor or, what is called "digestibility" is determined by calculating the difference between the content of the given substance in the daily fodder ration and its content in the daily excrement. However, the values obtained for "digestibility" are considerably lower than the real. Errors in determining "digestibility" depend upon the admixture, to the fodder substances contained in the digestive tract, of substances secreted by the peptic glands, and of internal substances secreted with the bile. The only way of determining this error is the method of tracer atoms. By intravenous introduction of salts, containing the radioactive isotope of an element (*e.g.*, phosphorus-32, or sulphur-35), and the subsequent discovery of this tracer element in the excrement, we can determine what part of this element, contained in the excrement, is of endogenous origin. Thus, it was established, that phosphorus-32 is secreted from the organism by all the divisions of the intestine and the pyloric portion of the stomach. Therefore, the amount of endogenous phosphorus in the excrement may reach considerable dimensions. The real "digestibility" of phosphorus proved to be three to five times greater than the apparent. That shows how great the error due to endogenous phosphorus may be in determining the "digestibility" of phosphorus.

With the aid of the isotope of sulphur-35 it has been proved that about 20% of the sulphur contained in the excrement is not of fodder origin but is carried into the intestine with the bile and is secreted from the organism by the walls of the intestines. Such data have been obtained for many substances.

Tracer atoms are also being used to study questions concerning the biochemistry and physiology of the milk, meat and wool yield of livestock and the oviparous properties of poultry, the preservation of livestock, the prevention of disturbances in metabolism and endemic diseases due to insufficiency or excess of certain microelements in the environment.

In highly-productive animals one may expect not only intensification of the synthetic processes, but also to a certain extent new trends of these processes, particularly, ways and forms of increasing the activity and utilising the primary, intermediary and end-products of metabolism. An important problem connected with the synthetic activities of the mammary gland, particularly in highly-productive milch-cows, is the utilisation of the issue depots of the organism for milk secretion. With the help of tracer compounds the quantitative ratios of the chemical components of fodder, the depots and the milk are being studied. The degree of

utilisation of mineral sulphur in the synthesis of thiamine, secreted with the milk, has been established.

Great attention has been devoted in recent years to a study of sulphur metabolism in sheep in connection with wool production. In these researches organic and mineral compounds of sulphur-35 (methionine, cystine, thiourea, thiamine, sulphates and sulphides), were used.

The introduction of marked sulphur into the organism of a sheep, for instance, leads to the deposition of sulphur compounds in the wool, leaving a radioactive track in it. When the introduction of tracer sulphur is repeated a few days later a second radioactive track appears in the wool. A special method is used to obtain this track : the clipped wool of a sheep is placed on a sensitive film, the film together with the wool is wrapped up in light-proof paper, and left thus for several days. The film, after development shows clear marks of radioactive tracer substances, in this case due to radioactive radiation of the tracer sulphur contained in the albumens of the wool. By measuring the distance between the two radioactive marks we determine the speed of growth of the wool. Many such marks can be made. This makes possible an objective measurement of the acceleration and retardation of the growth of the wool in accordance with the conditions of feeding and the biological state of the animals.

This method can also be used to determine the specific features of the growth of the wool of the fœtus, by giving radioactive substances to the sheep, while with young, and measuring the distances between the marks on the wool of the lambs after birth.

The process of calcification of the egg-shell in hens with a high laying capacity was also studied. With the help of calcium-45 it was shown that the calcium contained in the feed is deposited in the bones, and that only the skeleton serves as the direct source of calcium in the formation of the egg-shell.

In connection with investigation of the Urov endemic disease in the Amur and Chita Regions a study was made of calcium, phosphorus and sulphur metabolism (with the aid of chloride of calcium-45, phosphate, containing tracer phosphorus-32 and sulphate, containing sulphur-35) in the bones of animals in cases of excess of strontium in the fodder. A study of bone-sections established the influence of strontium on the deposition of calcium and phosphorus in the bones, and on the content of phosphorus and sulphur in the epiphyseal and articular cartilage. These researches are helping to establish the causes of the Urov disease and to find methods of combating it.

The method of tracer atoms, a new one in research, has a short history as yet but it has already enabled us to penetrate into the innermost processes of metabolism and to study processes of life hitherto hidden from us. The use of tracer atoms makes it possible to expand and deepen the range of theoretical problems which have to be studied for the solution of practical tasks of the development of animal husbandry.

ANIMAL ORGANISMS BUILD UP PROTEIN FROM BREATHED-IN NITROGEN

IT has been known for a long time that bacteria assimilate nitrogen from the air. At present, we know the mechanism of nitrogen assimilation by the bacterial cell and have a good knowledge of the enzymes involved in the process. As to plants, existing theory holds that they can utilise free atmospheric nitrogen solely due to the activity of soil bacteria and those living on the tubercules of bean plants. In both cases, bacteria combine atmospheric nitrogen into chemical compounds that can be assimilated by plants. There has so far been no indication that plants can assimilate nitrogen directly from the air. The way to absorbing atmospheric nitrogen in animal organisms appeared to be longer still. It was thought that animals could receive it only as part of vegetable food and not, by any means, directly from the air.

Certain experiments which recently have been carried out by Professor Mikhail Valsky, a mechanical engineer, indicate that animal organisms build up protein from nitrogen breathed-in from the air.

Valsky placed eggs in an incubator with an atmosphere in which the nitrogen was replaced by the inert gas argon. Within four days the embryos were dead, while eggs from the same batch kept in an incubator with a normal atmosphere (all other factors being kept equal) developed normally.

In another experiment young chicks were placed in an atmosphere identical with that of the first incubator. Within six hours their wings dropped and twelve hours later they were dead. Their brood-mates, kept under the same conditions, except that they had nitrogen in the air they breathed, developed normally.

As a final check, eggs were hatched in an incubator in which the ordinary nitrogen had been replaced by the stable isotope nitrogen-15. When protein taken from the embryos was analysed, it was found that there had been a significant increase in the nitrogen-15 content. This nitrogen could have come only from the atmosphere in the incubator.

These experiments seem to show that what used to be regarded as an inert gas and a diluent of atmospheric oxygen had proved to be a gas which is assimilated, though in small quantities, immediately from the air to become part of proteins forming in animal organisms. If further investigations confirm Valsky's findings, they may amount to a major breakthrough in modern biology. (*By Courtesy of the USSR Embassy in India.*)

OBITUARY

PROF. C. R. NARAYAN RAO

PROF. C. R. NARAYAN RAO, who died on January 2, 1960, took a prominent part in the development of Biology in the Mysore University over a period of thirty years. He was born in Coimbatore on August 15, 1882, and had his early education in Bellary. He later went to the Madras Christian College where he came under the inspiring influence of Professor Henderson who was the Head of the Zoology Department there. He graduated B.A. and later M.A. of the Madras University and was awarded a Gold Medal for proficiency. He obtained a Diploma in Teaching too. After brief periods of teaching in Coimbatore and Ernakulam, he came to the Central College, Bangalore, to organize its Zoology Department and remained its Head until his retirement in 1937.

Narayan Rao made important contributions to Science in India in two ways: first, by his researches on Indian Zoology and, secondly, by his activities in connection with the advancement of Science in the country. He named and described many new species of frogs and his presidential address to the Zoology Section of the Indian Science Congress in 1938 at Lahore dealt with the wealth of the problems in this rich group. His work on the Archenteric and Segmentation Cavities of Frogs was recognized by Goodrich as a reorientation of our concepts of Amphibian development. And his account of the ovarian ovum of the slender Loris formed part of J. P. Hill's Croonian Lecture to the Royal Society. It was under his inspiring influence that some of us came to recognize scientific research as an integral part of University teaching. If today, the Department of Zoology, Central College, has come to obtain the recognition as a centre of research in the country, it is entirely due to his initiative and inspired guidance.

Prof. Narayan Rao early recognized the need in India for a journal of the type of *Nature* in Britain. The increase in the tempo of scientific research in the Universities and Institutes of Learning demanded a vehicle for the speedy publication of results and with the initiative and support of Sir M. O. Forster and others, *Current Science* was started in 1932. On Prof. Narayan Rao fell the responsibility of being the journal's first editor. He discharged it so thoroughly and successfully that *Current Science* has now come to occupy an important position among the scientific periodicals of the world.

Again, it was in one of the editorials in *Current Science* (1932, 1, 335) that he urged the need for a scientific body in the country to co-ordinate scientific research and to provide a forum for scientific discussions and meetings. The founding of the Indian Academy of Sciences at Bangalore under the Presidentship of Sir C. V. Raman was a result of this appeal. He actively co-operated in the task of organizing the Academy, and the standing and reputation which the Academy now enjoys are due not a little to the sound basis on which it was founded.

Prof. Narayan Rao had a warm personality, intensely human and friendly. His death is a grievous loss to his many friends and past students.

B. R. SESHACHAR.

LETTERS TO THE EDITOR

SIMPLIFIED SKY COMPONENT EQUATIONS FOR A C.I.E. STANDARD OVERCAST SKY

RIGOROUS trigonometrical Sky Component Equations for a C.I.E. Standard Overcast Sky were derived by the author for a vertical rectangular opening.[1] Similar equations for a horizontal rectangular opening were subsequently derived.[2] Since the equations are difficult to employ in direct calculations, ready-made tables of calculated values for different openings have been prepared and will be published shortly.

It is however possible to reduce the equations to forms simple enough for use in direct calculations, and capable of giving the sky component values to a reasonable degree of approximation for window openings usually met with in practice. Equations for vertical openings for components in the horizontal plane are given in this note. Similar equations for other planes and for horizontal openings can be derived using the same method. In practice, sky components in the horizontal plane are those most required.

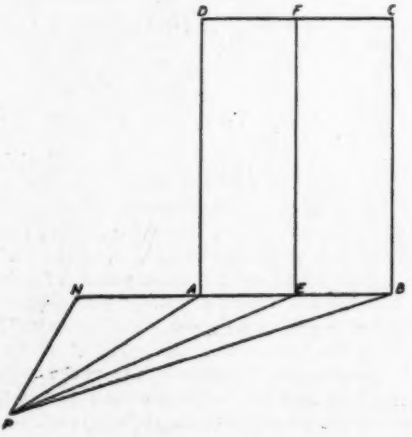

FIG. 1

ABCD represents a rectangular opening and P any point on the horizontal plane through the sill of the opening. N is the foot of the perpendicular from P on BA produced. EF is the vertical through the centre of the window. The following angles and distances are defined :—

$\hat{NPA} = \beta_1$ $\quad \hat{NPB} = \beta_2$ $\quad \hat{FPE} = \gamma'$

$EF = h$ $\quad NE = x$ $\quad PN = d$

$NA = l_1$ $\quad NB = l_2$ $\quad AB = l$

When P is on the perpendicular line passing through one of the lower corners A (N coinciding with A), $\hat{DPA} = \gamma$, $\hat{BPA} = \beta$, $\hat{BPC} = \gamma'$ and $\hat{CPD} = \beta'$.

All angles are expressed in radian measure. The values B_1 and B_2 give the values in degrees corresponding to the angles β_1 and β_2 respectively.

HORIZONTAL INTENSITY AT P DUE TO ABCD WHEN THE WIDTH OF THE OPENING IS NARROW

1. *With a C.I.E. Standard Sky*

Applying the rigorous equation

$$F_H = \frac{3}{14\pi}(\beta - \beta' \cos\gamma) + \frac{2}{7\pi}\sin^{-1}(\sin\beta \sin\gamma) - \frac{1}{7\pi}\sin 2\gamma \sin\beta'$$

and superposing the condition for narrow width, *viz.*, $\beta_2 - \beta_1 \approx 0$, the following expression for the horizontal sky component ratio (F_H) or percentage sky component ($\%F_H$) can be derived.

$$F_H = \frac{\beta_2 - \beta_1}{14\pi}[3\sin^2\bar{\gamma}' + 4\sin^3\bar{\gamma}'] \qquad (1)$$

$$\%F_H = \frac{B_2 - B_1}{25{\cdot}2} R^2 [3 + 4R] \qquad (2)$$

where

$$R^2 = \frac{h^2}{h^2 + d^2 + x^2}.$$

2. *With Uniform Sky*

The corresponding equations, for f_H and $\%f_H$ for a uniform sky are the following.

$$f_H = \frac{\beta_2 - \beta_1}{2\pi}\sin^2\bar{\gamma}' \qquad (3)$$

$$\%f_H = \frac{B_2 - B_1}{3{\cdot}6} R^2 \qquad (4)$$

where

$$R^2 = \frac{h^2}{h^2 + d^2 + x^2}.$$

RANGE OF APPLICATION

Equations 2 and 4 are true for extremely narrow openings only, but they are found in practice capable of application over a fairly wide range of widths, as can be seen from the following tables which give the comparative values calculated both from the approximate and the rigorous equations. In the following tables

columns headed E give the values calculated from the approximate equations (2) or (4) and the columns headed T give the values calculated using the rigorous equations.

Tables of sky component percentages

(*a*) *Uniform sky : N coinciding with A*

	l/*d*					
h/*d*	0·5		1·0		1·5	
	E(4)	T	E(4)	T	E(4)	T
1·0	3·58	3·56	5·56	5·57	6·11	6·47
1·5	5·01	4·99	8·04	8·03	9·23	9·52
2·0	5·83	5·81	9·52	9·51	11·25	11·44
2·5	6·31	6·29	10·42	10·39	12·51	12·63

(*b*) *Uniform Sky : N on BA produced*

$l_2/d \rightarrow$	1·0		2·0		2·0		3·0	
$l_1/d \rightarrow$	0·5		1·5		1·0		2·0	
h/*d*	E(4)	T	E(4)	T	E(4)	T	E(4)	T
0·5	0·71	0·72	0·12	0·12	0·37	0·40	0·08	0·08
1·0	2·00	2·02	0·39	0·40	1·21	1·30	0·27	0·29
2·0	3·68	3·69	0·98	0·99	2·83	2·92	0·80	0·83

(*c*) *Uniform Sky : N on BA produced : h*/*d* = 2

l_2/d	l_1/d	$(l_2-l_1)/d=0{\cdot}5$ E(4)	T	l_2/d	l_1/d	$(l_2-l_1)/d=1{\cdot}0$ E(4)	T
2·25	1·75	0·71	0·70	2·5	1·5	1·47	1·52
3·25	2·75	0·23	0·23	3·5	2·5	0·47	0·48
4·25	3·75	0·09	0·09	4·5	3·5	0·18	0·17

(*d*) *C.I.E. Standard Sky : N coinciding with A*

	l/*d*					
h/*d*	0·5		1·0		1·5	
	E(2)	T	E(2)	T	E(2)	T
1·0	2·95	2·95	4·50	4·54	4·80	5·21
1·5	4·50	4·50	7·12	7·14	8·01	8·37
2·0	5·46	5·45	8·83	8·83	10·27	10·53
2·5	6·03	6·02	9·89	9·88	11·76	11·92

(*e*) *C.I.E. Standard Sky : N on BA produced*

$l_2/d \rightarrow$	1·0		2·0		2·0		3·0	
$l_1/d \rightarrow$	0·5		1·5		1·0		2·0	
h/*d*	E(2)	T	E(2)	T	E(2)	T	E(2)	T
0·5	0·46	0·44	0·65	0·65	0·21	0·24	0·40	0·46
1·0	1·57	1·59	0·27	0·27	0·85	0·94	0·14	0·19
2·0	3·36	3·38	0·82	0·83	2·41	2·53	0·62	0·65

(*f*) *C.I.E. Standard Sky : N on BA produced : h*/*d* = 2

l_2/d	l_1/d	$(l_2-l_1)/d=0{\cdot}5$ E(2)	T	l_2/d	l_1/d	$(l_2-l_1)/d=1{\cdot}0$ E(2)	T
2·25	1·75	0·58	0·59	2·5	1·5	1·19	1·24
3·25	2·75	0·19	0·20	3·5	2·5	0·34	0·36
4·25	3·75	0·06	0·06	4·5	3·5	0·12	0·12

The above tables demonstrate that the approximate formulæ (2) and (4) give sky components correct to the first decimal place for values of $l_2 - l_1/d$ up to 1 at least. For example, the values will be reasonably accurate even for a window width subtending up to 90° (45° on either side) at P when that point is on the vertical normal plane through the centre of the window. In fact the equations give sky components for the usual sizes of windows at points over a large area of the room wherein sky components are usually required and to an accuracy adequate for all practical needs.

The sky component ratios for a window of semi-infinite height of any width or semi-infinite width of any height, with a C.I.E. Standard Sky, are respectively

$$F = \frac{\beta_2 - \beta_1}{2\pi} \qquad (5)$$

and

$$F = \frac{3}{28}(1-\cos\gamma) + \frac{1}{7\pi}(2\gamma - \sin 2\gamma).$$

The corresponding equations with a uniform sky are already known.

The author thanks Sri. R. C. Jain for his help in some of the calculations and the Director, C.B.R.I., for permission to publish this note.

Central Building Res. Inst., T. N. Seshadri.
Roorkee, *April* 12, 1960.

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EFFECT OF AGEING AND THERMAL HISTORY ON THE X-RAY DIFFRACTION OF CETYL ALCOHOL

The effect of ageing on the X-ray diffraction pattern of commercial paraffin wax was reported earlier by the authors in this Journal.[1] In the course of investigations on the Electret effect and the resulting orientations,[2] we have observed in cetyl alcohol a strong dependence of results on the ageing and thermal history of the material used in the study.

Technical grade of cetyl alcohol from B.D.H. Laboratory was used in the present study. The sample gave a long spacing of 46·7 Å, which is higher than other reported values (Table I). All diffraction patterns were recorded at the laboratory temperature of 24 ± 2° C. using Co K_α radiation and the flat-plate technique. Considering the short spacing rings, among a variety of mixed patterns, two basic types, *viz.*, types 1 & 2 (*see* Figs. 1 & 2 and Table I), could be distinguished.

TABLE I

Side-spacings observed in cetyl alcohol

Pattern type	Spacing, Å Units	Intensity (relative)	Remarks
Type 1 (Fig. 1)	4·16	very strong	In some cases one ring only at 4·13 Å
	3·99	medium strong	
Type 2 (Fig. 2)	4·16	very strong	Pattern similar to those paraffin hydrocarbons in the rhombic modification
	3·63	medium strong	
	2·38	weak	

Note:—Long spacing	Authors	46·7 Å
do.	Malkin[3]:—Vertical form	44·9 Å
	Tilted form	37·4 Å
do.	Kolp and Alpha form	44·3 Å
	Lutton[4]:—Sub-Alpha	44·9 Å
	Beta	37·2 Å

The 4·16 Å and 3·99 Å rings of the type 1 pattern showed considerable diffuseness and overlapped to form a single ring at 4·13 Å in certain photographs. According to Sano and Kakiuchi,[5] the important side-spacing rings (110) and (200) of cetyl alcohol are almost the same as those of paraffins at lower temperatures (4·2 Å & 3·8 Å). They approach each other as temperature increases and coincide exactly at a temperature near 20° C. The present authors could not find any such correlation between the fusing of the rings and the temperature, as both patterns (rings fused and separated) could be obtained at the same laboratory temperature.

The type 2 pattern (Fig. 2) is similar to those of paraffin hydrocarbons in the rhombic modification.

Cetyl alcohol was solidified in a special mica cell under a D.C. field of 10 KV/cm. X-ray patterns were recorded both with the beam perpendicular and parallel to the original field direction in the specimen, the former only showing orientation effects. The investigation proceeded under the two heads as follows.

A. Effect of Ageing

Diffraction photographs were recorded using freshly electrified specimens within 20 hours of preparation. The patterns were of type 1 (Fig. 1). The samples were then stored in a desiccator at laboratory temperature. Diffraction patterns were recorded from previously marked regions at regular intervals. After about 8 days a solid state transformation had taken place as shown in Fig. 2. In certain cases the original crystal modification still existed along with the new one after 8 days of ageing. The authors have found that the transformation can be reproduced to a certain extent by chilling the fresh specimen (both

FIGS. 1–3

Fig. 1. Cetyl alcohol. X-rays perpendicular to field direction. Taken within 20 hours of preparation. Co K_α radiation, Distance 3·88 cm. Exposure 50 minutes. Laboratory temperature 25·5° C. Fig. 2. Same specimen as for Fig. 1. Recorded after 8 days of ageing. Laboratory temparature 26° C. Most intense ring is the (110). Other rings are marked. Rhombic crystal form. Fig. 3. *Left*—Recorded using an unelectrified specimen of cetyl alcohol within 5 hours of chilling at 0°C. for an hour. Distance 5·77 cm. Exposure 2½ hours. *Right*—Recorded using an electrified specimen after same chilling operation as above. The middle diffuse ring corresponds to the old crystal modification. Exposure 4 hours.

electrified and unelectrified) at 0° C. for about an hour (Fig. 3). The tranformation, however, was not complete as evidenced by the presence of the ring corresponding to the original crystal modification. The results indicate that on ageing cetyl alcohol a solid state transformation ensues, whereby finally a stable crystal form is attained. A probable dependence of the results of investigations on the structure sensitive properties of cetyl alcohol, on the ageing period of the specimen, especially during the initial stages of ageing, is hereby indicated.

B. Effect of Thermal History of the Specimen

Both freshly electrified specimen and cetyl alcohol remaining in the beaker after preparation of a sample give patterns similar to Fig. 1, when recorded within about 20 hours of preparation. On storing them at laboratory temperature, the solid state transformation takes place after about 8 days as described in (A) above.

If the material that remained in the beaker (already transformed) is now remelted and fresh specimens prepared out of it, it is found that they give patterns similar to Fig. 2, and not the usual pattern (Fig. 1) recorded by other freshly prepared samples. Kakiuchi and Sakurai[6] have found that the results from specific heat studies on cetyl alcohol strongly depended on the thermal history of the specimen. This is understandable in view of our results that the crystal structure of the solidified material is dependent on the thermal history of the specimen.

It is pointed out that the above factors can influence the results of other studies on cetyl alcohol and must not be overlooked while interpreting results.

The authors would like to record their thanks to the Ministry of Education, Government of India, for the grant of a scholarship to one of them (K. C. C.).

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A GRADIENTLESS FURNACE

In a number of experiments it is desirable to have a cylindrical furnace in which there is no temperature gradient along its length. In a furnace with a uniform winding along its length there is usually a steep gradient as we pass from its centre to its ends. In the case of a long furnace we may obtain a small region of uniform temperature around the centre. But such furnaces are unwieldy and consume large power. The usual method of minimizing the temperature gradient is to increase the density of winding towards the ends of the furnace and by trial and error one can obtain gradientless condition along about half the length of the furnace. But the disadvantage of such a furnace is that the gradientless condition is obtained only for the temperature for which the furance is designed. As soon as the current in the winding is altered to obtain a new temperature, the gradientless condition is seriously disturbed.

A systematic attempt to discuss the temperature distribution in cylindrical furnaces has been made by Laubitz (1959). He has given design data which permit the construction of furnaces in which the temperature variation along the central half of the length of the heater is 0·5%. He has also given formulæ for the calculation of temperature distributions in conventional furnaces with uniformly wound heaters.

In this connection it may be mentioned that a gradientless furnace is in actual use in our laboratory for the last six months and it was felt that the details about this furnace would be interesting to workers in this field. The advantage of our furnace is that the gradientless condition can be obtained along a substantial length of the heater at any desired temperature without altering the nature of the winding. The furnace was constructed to study the variation of an interference pattern with temperature. The fringes being narrow could not be observed by means of a telescope as is done in the case of thermal expansion of crystals, and hence the system could not be placed at the centre of the furnace. The fringes had to be observed by a microscope and hence they had to be formed at a distance of about two and a half inches from the end of the furnace. (Our microscope had a range of 3".) In view of the steep gradient existing in the usual furnaces it was necessary to devise some means to remove the gradient along the length of the furnace from the centre up to about one inch from the end. This was achieved by winding the length of the furnace uniformly and providing an auxiliary winding

on the end faces in the form of a coiled coil spiral (Fig. 1 *a* and *b*). The end windings were

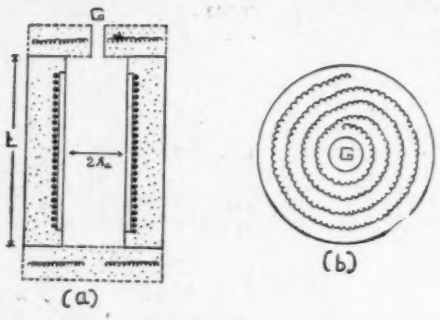

FIG. 1

symmetrical and were connected in series. The currents in the main (along the length) and the auxiliary windings were supplied separately and could be varied independently of each other. The interference pattern was observed through a small glass window G (Fig. 1 b). The dimensions of our furance are $L = 7{\cdot}5$ cm., $r = 3{\cdot}95$ cm., total length $= 11{\cdot}2$ cm.

The temperature distribution in the furnace, when no current flowed in the auxiliary coils, is shown in Fig. 2 *a*. The current in the end

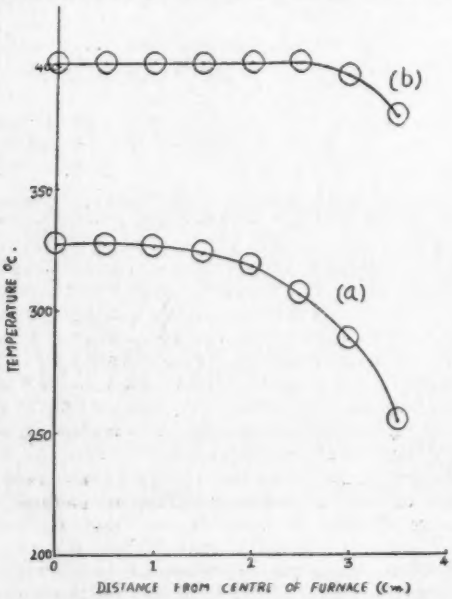

FIG. 2

coils was then slowly increased until the gradientless condition was obtained as shown in Fig. 2 *b*. The result of a systematic study of the furnace to obtain the values of the current in the two windings for different temperatures in the furnace is shown in Fig. 3.

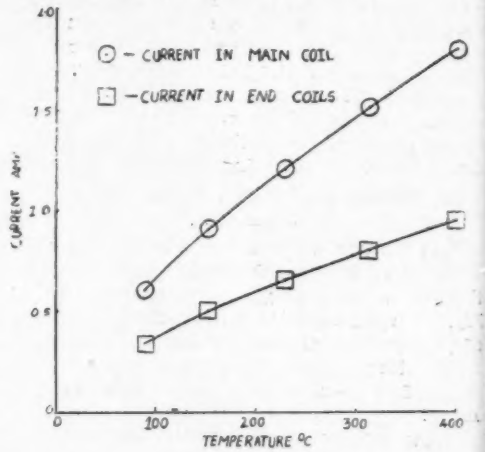

FIG. 3

Laubitz constructed furnaces based on his calculations of the design data. For $L/r = 16$ and $L = 20$ cm. he obtained a gradientless region of 32% of the length of the furnace for $T = 500°$ C. and 49% of the length for $T = 1{,}000°$ C. Fig. 2 *b* shows that in our furnace the absence of gradient extends to about 66% of its length. A furnace having the same diameter (about 4 cm.) but a larger length would show a much better performance.

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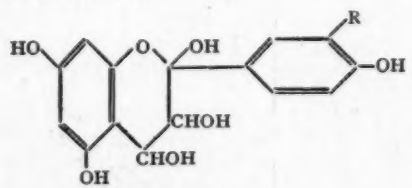
CONSTITUTION OF THE LEUCOCYANIDIN OF THE GROUNDNUT

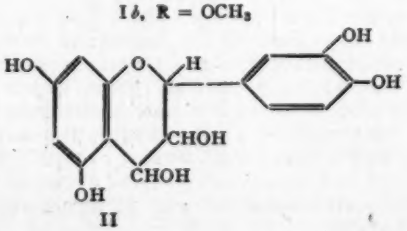
TAYEAU and Masquelier reported the isolation[1] of a mixture of leucoanthocyanidins from the skin of groundnut seeds and considered it to contain leucocyanidin (I *a*) and its 3'-methyl ether (I *b*) both having flavan-2 : 3 : 4-triol structure. We have now examined the various parts of fresh groundnuts. The kernels contain no leucoanthocyanidin and the shells only a very small amount. The pericarp (skin) is quite rich but it could not be separated out easily from the kernel of the fresh seed for extraction. Consequently whole kernels along with the skin, just as they are obtained after removing

the shells, were soaked in cold alcohol whereby the leucoanthocyanidin was conveniently extracted from the thin pericarp without appreciably affecting the components of the kernel. After evaporating the extract under reduced pressure, the leucoanthocyanidin was taken over in ethyl acetate and purified by fractional precipitation with light petroleum (40-60°). Eventually it could be crystallised from ethylacetate-lightpetroleum. It starts turning red at about 210° and decomposes at 275° (Found C, 56·1; H, 5·6; $C_{15}H_{14}O_7$, H_2O requires C, 55·6; H, 5·0%). Molisch test indicated that it was free from sugar; on boiling with alcoholic hydrochloric acid it gave rise to cyanidin.

The leucoanthocyanidin on acetylation formed an enol acetate which melted at 154-56°, with earlier sintering at 147°; $(\alpha)_D^{30}$ + 15·6° in methanol (Found: C, 60·0; H, 4·9; $C_{25}H_{22}O_{11}$ requires C, 60·2; H, 4·5%). Methylation of the leucoanthocyanidin with diazomethane yielded a tetramethyl ether which sintered at 140° and melted with reddening at 155-57°; $(\alpha)_D^{30}$, + 46° in methanol (Found: C, 64·0; H, 6·4; $C_{19}H_{22}O_7$ requires C, 63·0; H, 6·1%). The methyl ether on acetylation formed an acetate whose composition corresponded with the formula of an enol acetate; on heating it sintered at 130° and melted at 140-42° (Found: C, 65·4; H, 6·1; $C_{21}H_{22}O_7$ requires C, 65·3; H, 5·7%). The methyl ether on oxidation with potassium permanganate gave veratric acid. All these observations would lead to the conclusion that the leucocyanidin has a 3 : 4-diol structure (II) and not a 2 : 3 : 4-triol structure as suggested by previous workers.



Ia, R = OH
Ib, R = OCH_3



II

In order to exclude the possibility of a triol structure altogether, oxidation of the methyl ether has been carried out using periodic acid. This reaction has been used in the past not only for proving the existence of glycol structure, but also for the isolation of degradation products; the oxidation involves also the opening of the oxygen ring. Working up the products of oxidation of the methyl ether of the leucocyanidin from groundnuts, it has been possible to isolate an alkali insoluble aldehyde which is identified as veratric aldehyde; dinitrophenylhydrazone m.p. and mixed m.p. 256°. A phenolic aldehyde is also present and it has been characterised as phloroglucinaldehyde dimethyl ether by circular paper chromatography. This oxidation reaction could be explained satisfactorily only on the flavan-diol formula since the triol structure would have yielded on oxidation veratric acid and not veratric aldehyde.

In the course of this study, the presence of the 3′-methyl ether of the leucoanthocyanidin mentioned by previous workers could not be detected.

Chemistry Department, University of Delhi, Delhi-8, *March* 24, 1960.

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REACTION BETWEEN PIPERIDINE AND CARBON TETRACHLORIDE

DURING the course of our investigation on the molecular status of sulphur in solutions[1] of carbon tetrachloride and piperidine, we observed the formation of a compound by the reaction between carbon tetrachloride and piperidine even at room temperature (25°-27° C.). When a saturated solution of sulphur in carbon tetrachloride (25 g. of the solvent containing about 0·22 g. of sulphur) was treated with about 2 g. of piperidine, needle-shaped colourless crystals began to appear in about 10 minutes. With the progress of time, larger quantities of these crystals could be isolated. The crystals answered for chlorine and nitrogen tests but not for sulphur by the sodium fusion method.

A solution of piperidine in carbon tetrachloride also deposited similar crystals but the rate at which the crystals came out was extremely slow. About 22 g. of piperidine (Merck) was dissolved in about 120 g. of pure and dry carbon tetrachloride (distilled over P_2O_5) in a glass-stoppered bottle and set aside. The

liquid gradually assumed a reddish yellow colour and the solid was getting accumulated in the bulk of the liquid. In about 4 months, the entire mixture set into a jelly mass, reddish brown in colour. The solid was separated at this stage and washed with carbon tetrachloride. About 8 g. of the needle-shaped crystals with a yellow tinge was recovered.

The analysis of the crystals gave the following composition: C, 49·66%; H, 9·79%; N 11·69%. The chlorine content as determined by the Carius method was found to be 27·64%. Nearly the entire quantity of chlorine could be precipitated with silver nitrate and estimated by Volhard's method. The crystals melted at about 238° and were highly soluble in water and alcohol but not in benzene. The empirical formula of the isolated compound corresponds to ($C_5H_{10}NH.HCl$). The composition of the piperidine hydrochloride is C, 49·40%; H, 9·88%; N, 11·52% and Cl, 29·22%.

Even though it may be inferred that piperidine hydrochloride is formed by the reaction between carbon tetrachloride and piperidine, it is difficult to explain the mechanism and identify the products of the reaction completely. For instance, the mother liquor, freed from the crystals separated after 4 months, still began to deposit a further crop of crystals. This was separated after a period of further 5 months. The crystals (5 g.) were much more reddish and the mother liquor was intensely red which also began to deposit crystals. Analysis of the crystals gave nearly the same result as found in the earlier sample. It is likely that a trace of moisture initiates the reaction and the covalent bond chlorine is converted into hydrochloride which complexes with piperidine, a secondary amine. Sulphur may catalyse the process just as a metal like copper which has been recently reported while the present observation was under study.[2,3] Further work is in progress to elucidate the nature of this phenomenon.

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γ-SITOSTEROL FROM THE SEEDS OF *CLITORIA TERNATEA* LINN.

Clitoria ternatea Linn. commonly known as Aparajita belongs to Papilionaceæ subgroup of the Leguminosæ family and is known for its medical properties.[1–3] The seeds yield 18·78% of yellow fixed oil and its physico-chemical properties have earlier been reported by the author.[4] The oil from the seeds of *Clitoria ternatea* Linn. contained 1·62% of an unsaponifiable matter. The sterol has been isolated by the usual procedure adopted for the purpose[5–7] consisting of saponification of the petroleum ether extract of the seeds, followed by steam distillation to remove volatile matters. The non-volatile, non-saponifiable fraction, obtained by extraction of the liquor left after steam distillation with ether, contained the sterol. From this fraction, the pure sterol has been isolated by repeated crystallisation of the corresponding acetates and benzoates and by chromatography over Brockmann alumina column.

The sterol gave negative tests for N, P, S and halogen; positive Salkowski reaction and digitonin test and in the Liebermann Burchard reaction, it assumed a purple to blue and then green coloration. In the Steinkle Kehlenberg reaction, a purple coloration was observed which on exposure to light turned cobalt blue.

The sterol obtained as colourless shining plates was crystallised several times from ether-alcohol mixture (equal vols.) and finally from methyl alcohol, when it showed no alteration in specific rotation on crystallisation by the technique of Anderson[8] (yield 0·45% on dry weight basis of the seeds). Its m.p. was found to be 145·0°, $[\alpha]_D^{18}$ − 40·0° ($CHCl_3$), mol. weight (cryoscopic in benzene) 418 and contained carbon 83·96 and hydrogen 11·88% respectively corresponding to the mol. formula $C_{20}H_{50}O$. Its acetate prepared in the usual manner and benzoate by Callon's method[9] melted at 140·0°, $[\alpha]_D^{18}$ − 40·0° ($CHCl_3$), and 150·0°, $[\alpha]_D^{18}$ − 14·5° ($CHCl_3$) respectively and by the hydrolysis of these two derivatives the regenerated sterol was found to contain the original characteristics mentioned above.

The sterol has thus been identified as γ-sitosterol by the preparation of acetate and benzoate derivatives and comparing their percentage compositions, melting-points and rotations with those for known sitosterols. The characteristics of the sterol are in conformity with the earlier observations of Chakravarti *et al.*[10] and Sinha[11] on γ-sitosterol from the leaves of *Aegle marmelos correa* and *Tinospora crispa* respectively.

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MALACHITE GREEN AS A REVERSIBLE INDICATOR IN ACETYL CHLORIDE

MALACHITE green has been employed as a reversible indicator in benzoyl chloride.[1] In acetyl chloride visual titrations have been carried out with benzanthrone and crystal violet[2,3] as indicators. In the present investigations, malachite green has been employed as a reversible indicator for the detection of neutralization point of Lewis acids and bases in acetyl chloride. Solvoacids stannic chloride and titanic chloride have been titrated against solvobases pyridine, α-picoline, β-picoline, γ-picoline, quinoline, isoquinoline and dimethylaniline. The colour changes of this indicator in acidic and basic solutions in acetyl chloride and in water as well as in the pure solvents are given for comparison.

TABLE I

Solvent	Colour in the solvent	Acidic solution	Basic solution
Acetyl chloride	Green	Orange-yellow	Bluish green
Water	Green	Yellow	Blue

In the first set of these titrations solvoacids were used as titrants while in the second set of these titrations, the solutions of the solvobases quinoline, α-picoline and dimethylaniline only were used as titrants because other solvobases are sparingly soluble. In all these titrations the colour at the end point was determined by the colour change at the volume used close to the theoretical end point. In most of the titrations, the colour at the end point comes out to be some shade of green which varies from dirty green, light green to yellowish green. But there are instances in which the colour change at the end point is yellow when acidic or basic solutions are used as titrants. These extraordinary cases are useful in deciding the relative strength of bases. The presence of green, light green and yellow colour at the end point with quinoline, α-picoline and dimethylanilline respectively as titrants appear to indicate the relative order of strength of these bases as under :

Quinoline > α-picoline > dimethylaniline

This observation is supported by the results already reported in acetyl chloride.[3] In certain cases it is rather difficult to find out the correct order of strength of bases and acids as colour changes of malachite green vary through a wide range of pH values.

Investigations with other indicators in acetyl chloride as well as in other acid chlorides are in progress and details of this work will be published elsewhere.

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PECTIN DECOMPOSITION BY ACTINOMYCETES

IN view of our limited and fragmentary knowledge regarding micro-organisms fermenting pectin, a systematic survey of the activity of micro-organism to decompose pectic substances was started in 1958. This entailed not only isolation and identification of pectolytic microorganisms by the enrichment culture methodology but also the screening of many species and strains of bacteria, yeasts, actinomycetes and moulds.

Out of the 45 yeast cultures examined only a marine yeast, *Cryptococcus laurentii*,[2] showed distinct pectolytic activity. Several species, however, are able to utilize the breakdown products of pectin. Surprisingly enough most of the actinomycetes tested displayed positive activity as indicated by demethylation or glycosidic

hydrolysis, or both, of the pectin molecule. The method of Bell and Etchells[1] was adopted for an elucidation of these changes. The widespread pectolytic activity of actinomycetes is rather surprising since none of the cultures were isolated or maintained on media containing pectic substances. The results (Table I) suggest that actinomycetes play a dominant part in the breakdown of pectic substances in Nature. There has been an underestimation of their pectolytic activity possibly due to their slow growth in pectin enrichments and a consequential failure to detect such activity.[3-5]

TABLE I

Nature of the chemical action on the pectin molecule	No. of actinomycete cultures showing positive action
Demethylation ..	28
Glycosidic hydrolysis ..	100
Demethylation and glycosidic hydrolysis ..	15
No action on pectin ..	6
Total number of cultures tested ..	149

A more critical examination may reveal a higher incidence of demethylation which might have escaped detection in a preliminary screening when side by side there is glycosidic hydrolysis. A more detailed report will be published later.

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INFLUENCE OF SEX HORMONES ON THE UPTAKE OF Zn^{65} BY THE RAT LIVER

THE high Zn content of the prostate has been repeatedly observed in different species including man.[1] Selectiye uptake of Zn^{65} by the dorsolateral prostate of the rat has also been recorded.[2] Sex hormones and gonadotrophin influence such prostatic accumulation of Zn^{65} in one manner or other.[3-5] The present communication records findings pertinent to any effect of sex hormones on uptake of Zn^{65} by the rat liver.

Male albino rats (250-280 gm.) were divided into 3 groups of 8 animals each. Care was taken to match a control animal with its litter mate for receiving hormone treatment. Testosterone propionate and estradiol benzoate (5 mg. daily/rat) was injected intramuscularly for 4 days. The control animals received arachis oil alone. Carrier-free $Zn^{65}Cl_2$ in isotonic saline solution was administered by the intraperitoneal route 12 hours after the final hormone treatment. The dosage/rat was 0·5 ml. giving 120,000 counts/minute under standard counting conditions. The animals were sacrificed at 10 hours after the injection of the isotope for reasons indicated earlier.[3] The liver was dissected out, blotted to remove any excess blood and weighed to the nearest 0·1 mg. Pieces of the gland of equal weight were then digested in KOH by heating over a steam-bath for 1 hour. The volume of the digest was finally made up to 10 ml. with distilled water and its radioactivity was measured in a Geiger-Müller counter (type "M6", 20th Century Electronics Ltd., England) in combination with a decade scaler. All counts were corrected for background, dead time and radioactivity decay. The counting error did not exceed 1%.

TABLE I

Zn^{65} uptake by the rat liver under the influence of sex hormones

Treatment	Counts/minute/gm. liver Mean ± S.E., Range
(a) Controls (Arachis oil)	23412·5 ± 8835·7 (20400·0*—28600·0)
(b) Testosterone propionate (5 mg. daily/4 days)	28575·0 ± 10835·1 (22800·0 – 36700·0)
(c) Estradiol benzoate (5 mg. daily/4 days)	33812·5 ± 13099·7 (25400·0 – 53200·0)

* Range.

It will be evident from Table I that both androgen and estrogen tended to increase the rate of accumulation of Zn^{65} by the rat liver; the latter hormone being more effective in this respect. However, because of variation in count rates the difference between the groups did not yield statistically significant results (a vs. $b - t = 0{\cdot}38$ P $> 0{\cdot}8$; a vs. $c - t = 0{\cdot}65$ P $> 0{\cdot}6$; b vs. $c - t = 0{\cdot}30$ P $> 0{\cdot}8$). Nevertheless, the trend of modification in the rate of uptake of Zn^{65} by the liver was interesting because of the known influence of sex hormones on metabolism of this gland.[6]

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Pharmacology, University of Birmingham, England, where part of this investigation was carried out.

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PATTERN OF FOOD AND BLOOD CHOLESTEROL

IT has been shown[7] that blood cholesterol was related to age, obesity, exercise and perhaps total food/fat intake. In a study on recruits[9] it was observed that, irrespective of the dietary fat different provincial groups consumed before recruitment, their blood cholesterol did not differ from one another significantly; this was attributed to fat providing less than 10% of total calories in the diet of poor agricultural community, from which they came. Army diet, with 3,750 total and 24% fat calories, produced a sharp rise in the blood cholesterol reaching a peak in 3 months and then stabilization at the high level. Even when these sepoys reverted to their original dietary fats, as it happened with every soldier on restoration to his family life, there was no fall in the level of their blood cholesterol. Comparison of different professional groups in the army and civilian blood donors indicated a pattern of blood cholesterol peculiar to each group. Fat intake at a level of less than 10% of total calories showed that whatever the fat consumed the blood cholesterol remained low. Similarly blood cholesterol values of officer cadets (unpublished), when compared with sepoy recruits described earlier, suggested a maximum upper limit of fat calories beyond which different fats irrespective of their degree of unsaturation failed to exert any influence on blood cholesterol metabolism. Accordingly it looked desirable to study (a) the effect of two fats, *viz.*, hydrogenated groundnut oil and safflower oil at a medium level of 18% fat calories; (b) the influence of pattern of food in general and cooking in particular; (c) the chronic effect of these fats on blood cholesterol. Therefore the following series of experiments have been carried out:

I. Fifteen clinically normal persons from the Punjab between the ages of 21-36 years, from three families of 5 persons each and made up of 4 men and 1 woman, habituated to consuming hydrogenated groundnut oil as cooking medium, formed the first group. Their average food intake was 2,900 ± 100 calories, with about 18% fat calories. After recording their starting blood picture they were put on to safflower oil which completely replaced the hydrogenated fat. There was no other change in their diet.

II. Fifteen clinically normal persons from Maharashtra of approximately similar dietary intake, age and sex from three families of 5 persons each and used to consuming safflower oil as cooking medium, formed the second group. They changed over to hydrogenated groundnut oil for their cooking fat. As in the first group, there was no other change.

III. With a view to ascertain the possible effects of pattern of cooking, two groups of 5 persons each of the same age and sex composition as in groups I and II and habitually consuming hydrogenated groundnut oil and safflower oil respectively changed over (a) their cooking fat as if they had formed part of groups I and II; (b) their pattern of cooking to that of Western system. Total calorie intake was however kept constant at 2,900 ± 100 with the same 18% fat calories.

At the start of the experiment their bloods were examined for hemoglobin by Sahli's method as modified by Newcomer,[4] total protein by specific gravity method,[6] E.S.R. by Wintrober's method[10] and blood cholesterol by Bloor's method converted by a factor of 0·82 to Anderson and Keys values.[5] Approximate composition of diet was: carbohydrates 500 gm., proteins 90 gm., fats 60 gm.,* and adequate quantities of vitamins from vegetables, fruits and milk and butter-fat. All the 40 persons consumed their respective fats/patterns of diet for a period of one year. Repeated blood tests were made at 3, 4, 6, 8 and 12 months intervals. Records were kept of their weights to account for gross changes, if any.

OBSERVATIONS

Results of the findings in groups I and II are presented in Figs. 1 and 2. The following inferences are drawn:—

1. The hypercholesterolemic effect of hydrogenated groundnut oil was transitory and so was the hypocholesterolemic action of safflower oil.

* Hydrogenated groundnut oil/safflower oil 30 gm.; milk fats 10 gm.; all other 20 gm.

2. There was restoration of blood cholesterol after one year's consumption of new fat in 4 out of 6 families. In the remaining two, there was a similar tendency to come to normal.

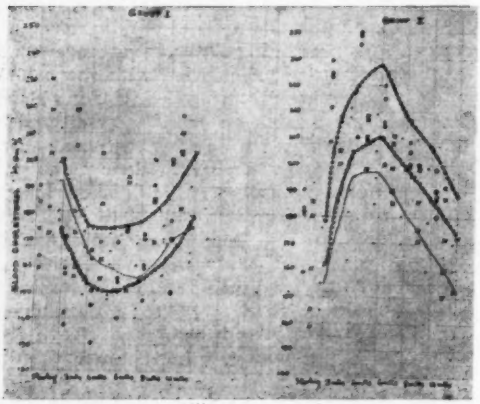

FIG 1

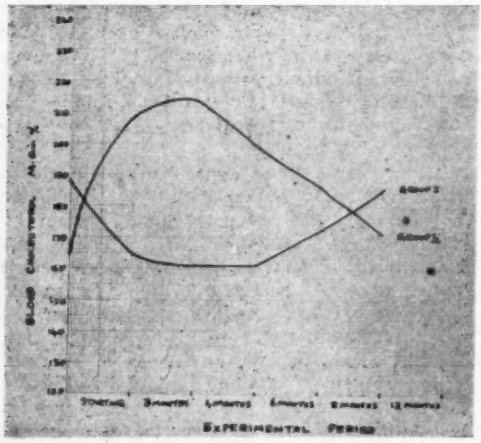

FIG. 2

3. Initial hypercholesterolemic action of hydrogenated groundnut oil was stronger than the hypocholesterolemic activity of safflower oil.

4. There was a trend to indicate that if the starting blood cholesterol was high the safflower oil produced a steep fall, and similarly if the blood cholesterol was low in the beginning the hydrogenated fat caused a sharp rise.

5. The importance of the pattern of food was evident not only within the groups, but also between the groups.

6. Since there was adaptation of the organism to different fats at medium level of intake and no effect on blood cholesterol at low levels at all, the most important factor that emerged out of this study was that the hypercholesterolemic action of the fats was the result of intake of excessive fats and at that level the degree of unsaturation of a fat failed to exert any influence on the levels of blood cholesterol.

In the third group, results of which are given in Table I, findings differ from groups I and II in (a) that safflower oil produced a smaller fall in the level of blood cholesterol with quicker recovery than group I and was followed by a continuous rise; (*b*) that the hydrogenated fat produced a progressive rise without any fall after 8 months as noted in group II.

TABLE I

Effect of pattern of cooking (change over from Indian to Western style)

S. No.	Class	Blood cholesterol mg./100 ml.					
			after				
		At start	3 months	4 months	6 months	8 months	12 months
1	Change-over from hydrogenated fat to safflower oil	191	185	178	190	210	225
2	Change-over from safflower oil to hydrogenated fat	182	193	210	205	222	231

Observations recorded in Table I show that maintenance of high blood cholesterol in the earlier study (Verma and Sehra, *loc. cit.*) even after prolonged use of these fats could have resulted from excessive calories and fat intake. It is well known that excessive food and fat intake, having saturated or unsaturated fatty acids produced high blood cholesterol levels,[2,3,8] this is also borne out indirectly from pathological conditions characterised by hyperlipæmia having elevated levels of blood cholesterol. Furthermore this study with medium fat intake has helped to clarify the earlier confusion regarding the specific effect of unsaturated fats which mostly resulted from short-term experiments.

Findings from group III seem to bring out another factor which probably contributes to the rise of blood cholesterol. With the limited data it is not possible to say whether cooking alone could be responsible for this rise.

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VERTEBRATE FOSSIL-BONE FROM UMIA BEDS (UPPER JURASSIC OF CUTCH)

A SPECIMEN of a vertebrate fossil was collected by the author from Bhujia Hill (69° 43′ 40″ E., 23° 15′ N.) about a mile south of Bhuj.

The specimen was found on the north-western slopes, about 30 ft. below the fort wall, and it was embedded in coarse-grained sandstone of Umia marine sandstone age. Wynne (1872), Raj Nath (1942), Krishnan (1956) have proposed Upper Jurassic or Lower Cretaceous age for these beds.

In this specimen hard parts have been replaced by coarse-grained sand, and the soft parts are not preserved. Due to poor preservation much of the detail has been lost; however, the following information could be gathered.

It has eight preserved ribs and twenty poorly preserved vertebræ. The ribs are attached to the anterior eight vertebræ. The vertebræ have been completely replaced by pink sand, but the ribs are marked by only white bands in the sand. All the vertebræ are in their places but their articulate surfaces are not distinct. The ribs have been affected by a small post-fossilisation fracture, along which some minor displacements have taken place, but the continuity of the ribs is not lost.

The vertebral column is 36 cm. in length and before preservation it was probably broken and bent at right angles. The break has taken place below the eighth vertebra and the last rib. The length of the anterior eight vertebræ, to which the ribs are attached, is 18·5 cm. and the remaining twelve vertebræ are 17·5 cm. in length. The vertebræ decrease in width anteroposteriorly; the arteriormost vertebra is 3·5 cm. wide and the last vertebra is only 1·5 cm. wide. The ribs are attached with the centre of the anterior eight vertebræ while the other parts of the remaining vertebræ are not distinct.

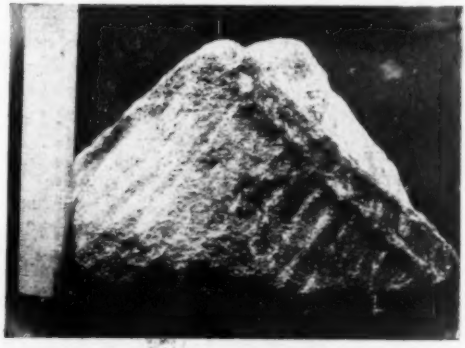

FIG. 1

The ribs appear to have been joined to the vertebræ on the dorsal side of the specimen and on the ventral side they are joined by sternum. The sternum is well preserved and extends like a band from the first rib to the last rib. Each rib is represented by two thin white bands which suggest that during life they were either hollow or ossified.

Wynne (1872, pp. 129-30) has reported the occurrence of vertebrate fossils from the jurassic deposits of Eastern Cutch but so far none is reported from Bhuj area. As mentioned above, due to lack of details and the absence of the skull, it is impossible to suggest any generic identification, but because of its association with Upper Jurassic or Lower Cretaceous deposits it can be suggested that it is a reptilian fossil. Wynne (1872) has reported the occurrence of crocodile fossils from the beds of the same age, but in the present case even this identification is not possible.

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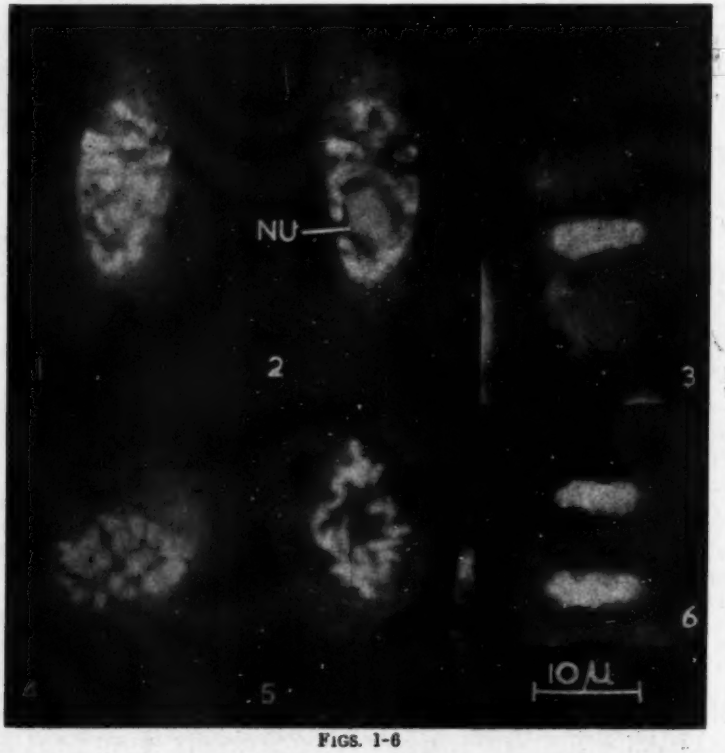
THE EFFECT OF ACID HYDROLYSIS ON THE COLOURS OF THE SECONDARY FLUORESCENCE OF THE CELL ORGANELLES STAINED WITH ACRIDINE ORANGE

On staining living yeast cells with acridine orange at a critical dilution of ca. 1 in 40,000, the chromocenters fluoresced green while the nucleolar equivalents were deep orange.[1] The cytoplasm of adjacent cells were green or light orange. The nuclear membrane had the same tint as the cytoplasm of these cells. A longer stay in the stain or exposure to a higher concentration of the dye resulted in most of the cell organelles emitting a bright orange fluorescence. The chromocenters which were green at the beginning turned orange quickly in higher concentrations.[1]

In the context of the similarity in structure of yeast and plant nuclei,[2] a study of the reactions of the nuclear organelles of plant cells to acridine orange became interesting. The root-tips of 1-3 day old seedlings of *Phaseolus radiatus* Linn. were chosen for investigation. The living root tips did not give good squashes. Therefore, those preserved in acetic alcohol for periods ranging from 1-24 hours were used. These did not yield a uniform separation of the cells on squashing. In regions where the cells were scattered, the chromatin was green and the cytoplasm orange. The nucleolus was green at first but turned orange later.

To obtain good squashes, therefore, the root-tips freed of the fixative, with grades of alcohol followed by distilled water, were hydrolysed in N HCl at 60° C. for 5-6 min. They were then washed in repeated changes of distilled water for 10 min. and transfered to acridine orange (1 : 40,000) prepared in glass distilled water. After a stay of five minutes, the tip was teased into smaller bits in a drop of the fresh stain on a slide and kept aside for a



FIGS. 1-6

Figs. 1-2. Early prophase. The nucleolus (NU) is seen in Fig. 2. Fig. 3. Metaphase. Figs. 4-5. Polar views of chromosomes. Fig. 6. Late Anaphase.

period of five minutes. The extra stain around the coverslip was removed with filter-paper strips, the material was squashed and the preparation then sealed with paraffin wax. A Zeiss super-pressure mercury lamp with an appropriate blue filter was used for examination.

When the cells were well separated and scattered their cytoplasm and nucleoli fluoresced green while the chromocenters were deep orange. In regions where the cells, though in a single layer, were crowded together, only those at the periphery had the cytoplasm green and the chromatin orange. As one proceeded towards the centre of the mass, they had green cytoplasm and greenish yellow chromocenters. The chromosomes at meta- and ana-phases alone were orange in the interior of the cell cluster. This differing grade of fluorescence in a closely packed group of cells may be the consequence of the limited quantity of the dye available around the cells in the interior of the cluster.

To obtain optimal staining several factors have to be controlled. The fixed material has to be downgraded, washed well in distilled water and then stored in 70% alcohol if the staining is not being carried out immediately. Otherwise, a granular precipitate appears in the squashes. The above phenomenon was, however, not observed in the root-tips of *Pisum sativum*. The same type of precipitate appears also if the hydrolysed material is not washed well in distilled water. A longer stay in distilled water after hydrolysis makes the cells refractory to staining.

The chromocenters and chromosomes exhibit a bright orange fluorescence. This renders difficult the location of the green nucleolus lying among them. On exposure to the ultraviolet lamp, there is a gradual loss in intensity of the orange fluorescence when the nucleolus begins to stand out as a green structure. This is illustrated in Figs. 1 and 2 of the same cell taken consecutively. The time for the first exposure was 150 secs.

When the cytoplasm and the nucleolus are orange and the chromatin green, as in fixed but unhydrolysed material, the latter show little contrast in photographs. The reversal of the fluorescence of the organelles by hydrolysis enables presentation of clear pictures of the bright orange chromosomes. Figure 3 is a metaphase plate and polar views of chromosomes are presented as Figs. 4 and 5. A late anaphase is illustrated in Fig. 6.

The fluorescence of the chromatin and nucleolus in fixed but unhydrolysed cells of *Phaseolus radiatus* resemble that seen in the living nuclei of yeast[1] on staining with acridine orange. There appears to be a consensus of opinion that the intra-nuclear structures containing DNA emit a green[3–7] or yellow[8] fluorescence on staining with acridine orange. The same cannot be said of structures fluorescing orange since they may contain mono-nucleotides or muco-polysaccharides.[7]

The complete reversal of the fluorescence of the chromatin from green to orange and the cytoplasm and nucleolus from orange to green on hydrolysis of the cells before staining awaits, therefore, a rational explanation.

One of us (S. R.) is grateful to the University Grants Commission for the award of a Senior Research Fellowship.

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EFFECTS OF RADIATIONS ON THE NUTRITIVE QUALITY OF BREAD WHEATS

FIELD observations like increased grain size, increased grain weight and colour followed by laboratory investigations have established the value of utilizing ionizing radiations for improving the nutritional quality of bread wheats.

Seeds of the two varieties of wheat, *viz.*, RS 31-1 and C 591 were got treated by the Atomic Energy Establishment at Bombay with different doses of pile neutrons, the doses being —0·5, 1·5, 4·5 and $13{\cdot}5 \times 10^{13}$ np./cm.^{2} Treated seeds were grown to maturity. Harvested seeds were analysed chemically so as to see the effects of neutrons on nutritive quality of these bread wheats. Seeds from the whole plot dealing with each treatment were collected and analysed collectively as a preliminary step. Whether the effect of the treatments is permanent will be

known only when the progenies of treated individual plant are grown and studied. The single plant analysis is already in progress. The present observations, however, led to some interesting findings.

The data given in Table I show that proteins increase significantly in all the treatments in both the varieties C 591 and RS 31-1 over the controls. It is to be noted that the protein content varies in the two varieties themselves. A similar increase due to treatment was also observed in nitrogen contents but the data have not been included in Table I.

TABLE I

Table showing chemical analysis of various treatments and controls

Sl. No.	Treatments Dose $\times 10^{13}$ np./cm.^{2}	Protein %	Moisture %	Carbohydrate %	Total ash	No. of analysis
1	0·5—RS 31-1	13·25*	8·36	67·23*	1·99*	4
2	1·5—RS 31-1	12·35*	9·56*	65·49*	2·04*	4
3	4·5—RS 31-1	13·75*	9·80*	66·17*	2·36*	4
4	RS 31-1 Control	9·90	8·68	61·87	1·17	4
5	0·5—C 591	14·63*	8·20	65·71	3·24*	4
6	1·5—C 591	8·55*	10·21*	62·99	2·29*	4
7	4·5—C 591	13·95*	9·30*	67·03*	2·00	4
8	C 591 Control	8·13	8·53	63·02	2·12	4

N.B.— Treatment $13·5 \times 10^{13}$ np./cm.^{2} proved lethal in both the varieties. Figures marked with asterisk (*) are significant over controls.

Moisture percentage shows a significant increase over the controls in the treatments 1·5 and $4·5 \times 10^{13}$ np./cm.^{2} of both RS 31-1 and C 591 varieties.

There is a significant increase in the carbohydrate content in all the treatments of RS 31-1 over the control. C 591, however, shows a significant increase only in one treatment, *viz.*, $4·5 \times 10^{13}$ np./cm.^{2}

Total ash contents have significantly increased in all the treatments of RS 31-1 and in 0·5 and $1·5 \times 10^{13}$ np./cm.^{2} treatments of C 591 as compared to their respective controls.

We are thankful to Dr. K. C. Bora of the Atomic Energy Establishment, Bombay, for treating the seeds. Thanks are also due to the Agricultural Chemist, Rajasthan, for analysis of seed samples.

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A NEW TYPE OF CLUSTERING IN RICE

NORMALLY the spikelets of rice are arranged in singles along the main and secondary branches of the panicle. In certain varieties, however, the spikelets are arranged close together in groups and this grouping of spikelets is referred to as clustering. In the simple type of clustering observed by us in the variety A.C. 1224 (Fig. 1), spikelets occur in groups of threes,

FIG. 1

occasionally in fours or fives, but rarely above five. A few of the spikelets in the panicle occur in singles as well. Ramiah[6] has reported occurrence of clustering in groups of 2-5 in the variety E.B. 331, while Ghose *et al.*[1] have reported 2-7 spikelets in a cluster.

Occurrence of simple clustering has also been reported by Jones[2] and Jodon[3,4] from U.S.A. and Nagao[5] from Japan. In the present note, a new type of clustering, which has not been reported so far, is described.

In 1956, bulk seed of variety A.C. 3776 was received from Travancore. The variety, when grown at this institute, was found to have two types of plants—a majority with normal panicles and a few with clustered panicles. The clustered panicles differed from the simple clusters reported previously, in that the spikelets were arranged in groups of 10-48 (Fig. 1), the terminal clusters having more spikelets than the lateral ones. On closer examination, the spikelets were found to be arranged very closely in bunches and the panicles exhibited interrupted clusters [somewhat more interrupted than those observed by Ramiah (*loc. cit.*) in E.B. 331] as against the simple clustering in

A.C. 1224, in which the arrangement of spikelets, both in singles and in groups, is continuous. This new type of cluster is being named by us as Super-Cluster. The length of panicle and the number of spikelets in each cluster, observed in five random panicles, are given in Table I.

TABLE I

Sl. No. of panicle	Length (cm.)	No. of clusters	Range of spikelets in a cluster
1	18	11	14–48
2	18	7	12–36
3	17	10	10–35
4	18	12	10–21
5	14	8	11–18

Clustering has been reported to be partially dominant over no clustering by Ramiah,[6] Jodon[3] and Nagao.[5] These authors have assigned the symbol cl to denote the simple cluster gene. In the present study, in a cross between the simple cluster and the Super-Cluster type (A.C. 3776), the F_1 showed partial dominance of the Super-Cluster. Bunching was very prominent and the number of spikelets in each cluster was intermediate between the two. It is proposed to designate the gene for the Super-Cluster as scl to distinguish it from the other, as the genes appear to be different. Further work is in progress to study the inheritance of this cluster and its interrelationship with other types of clustering.

The authors are grateful to Shri R. L. M. Ghose, the then Geneticist and Botanist, for his interest and encouragement.

Central Rice Res. Inst., Cuttack, *January* 24, 1960.

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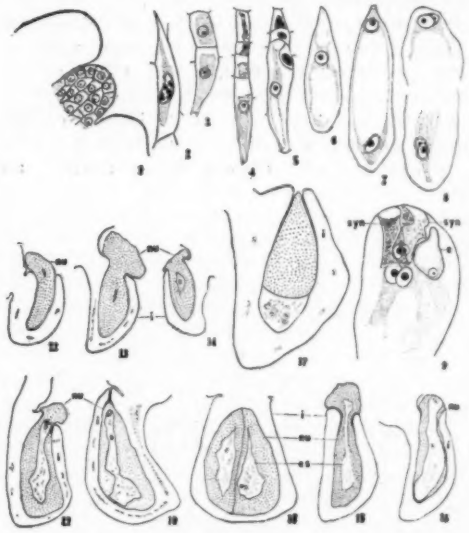
EMBRYOLOGY OF *EUGENIA MALACCENSIS* LAM.

Eugenia malaccensis Lam. (*Syzygium malaccense* L.) was examined embryologically by Pijl[1] who reported the occurrence of integumental polyembryony in the species. Embryological studies of the material collected by me from the Indian Botanic Gardens, Calcutta, showed the following interesting features besides polyembryony.

The development of the female gametophyte is of the Polygonum type. The ovule which is unitegmic and crassinucellar is curved before any differentiation of the archesporium occurs (Fig. 1). Meiosis is normal (Figs. 2-4) and the



FIGS. 1-18. Fig. 1. L.s. young ovule showing undifferentiated cells of nucellus, × 288. Figs. 2–9. Stages in the development of embryo-sac, × 356. Fig. 10. L.s. normal ovule, × 29. Figs. 11–16. L.s. abnormal ovules showing protruding nucelli through micropyle, × 29. Fig. 17. L.s. abnormal ovule showing broad micropyle and an embryo-sac-like structure with three nuclei adhering to nucellus and integument, × 75. Fig. 18. L.s. ovule showing double nucelli, × 29.

(Abbreviations: *e*, egg; *es*, embryo-sac; *i*, integument; *nu*, nucellus; *syn*, synergid.)

tetrad is deep-seated. The chalazal megaspore is the largest and functional (Fig. 5). The formation of one-, two-, and four-nucleate embryo-sacs is normal (Figs. 6-8) and the mature gametophyte is characterized by the absence of the ephemeral antipodal cells (Fig. 9).

The embryo-sac may occupy varied positions within the nucellus. The growth of the embryo-sac was rather peculiar in certain ovules. Due to the expansion of the upper half of the embryo-sac towards the micropyle the nucellar cells are crushed till the sac comes to lie directly against the nucellar membrane formed by the outer wall of the nucellar epidermis (Fig. 16).

Normally the single integument completely covers the nucellus except in the region of the micropyle (Fig. 10). In abnormal ovules the nucellus is found to protrude through the

integument and broaden out. The integument covers only the lateral and the lower regions of the nucellus and may not reach the summit so as to form the micropyle. In the region where the integument clasps the nucellus, the latter may be constricted (Figs. 11-16).

A large number of ovules contained no embryo-sacs ; they show only a mass of nucellar cells and grow along with the other ovules containing an embryo-sac and finally degenerate. Ovules showing no organization of the nuclei in their embryo-sacs were also noted. The chalazal end of one ovule showed an embryo-sac-like structure with only three prominent nuclei embedded in a mass of cytoplasm. In the light of investigations on other species of Eugenia studied by mé (Roy),[2] it may be an aposporic embryo-sac formed directly from a cell near the chalazal end of the nucellus in an otherwise sterile ovule. Aposporic embryo-sacs are known to show such an abnormal number and disposition of nuclei in them (Maheshwari).[3]

Double nucelli each containing an embryo-sac but enveloped in a common integument were also observed in some ovules (Fig. 18). Embryo-sacs in such ovules did not show any healthy nuclei and degenerated ultimately.

My grateful thanks are due to Prof. P. Maheshwari and Dr. S. Narayanaswami for guidance.

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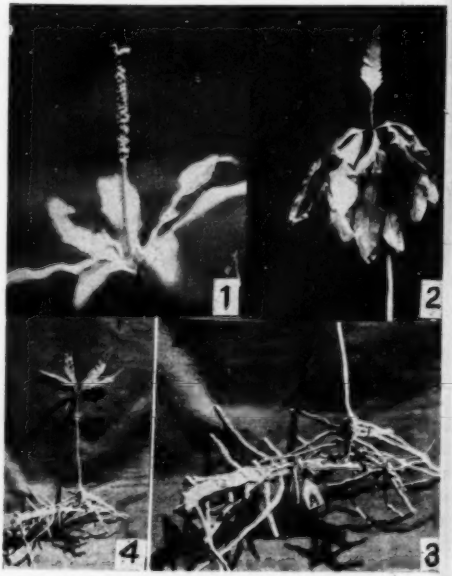
SOME ABNORMALITIES IN *HELMINTHOSTACHYS ZEYLANICA*

ABNORMALITIES in *Helminthostachys* have been rare. Prof. Von Goebel has recorded some examples which later have been quoted by Bower.

The author came across the following cases of abnormalities while collecting the specimens in Mysore forests.

According to Bower, the spike of *Helminthostachys* is often subject to accessory branchings and these may be combined with correlative vegetative growth where sporangia are absent as in *Botrychium*. There appears to be a balance between the vegetative and sporangial development. Figure 1 shows the spike of *Helminthostachys* dividing into two branches at its termina end with consequent increase in the spore output. The vegetative growth is normal o slightly subnormal. Figure 2 shows a spike o



FIGS. 1–4. Fig. 1. *Helminthostachys zeylanica* with a bifurcating spike, × 1/4. Fig. 2. Sterile spike of another plant has become flat and geen bearing sporangia on the basal stalk, × 1/4. Fig. 3. Axillary branches developing on the main rhizome. At A a young bud is shown, × 2/3. Fig. 4. Entire plant of *H. zeylanica* shown on a large scale in Fig. 3, × 1/6.

Helminthostachys which has become partly expanded into a green (lobe) with a long cylindrical (basal) stalk bearing on either sides isolated sporangia. Vegetative development in this case has taken place at the expense of the sporangial development. This can conveniently be taken as a stage of condensation to the spike of *Ophioglossum*, which, according to Bower, is more specialised than that of *Botrychium* or *Helminthostachys*.

Formation of axillary buds has been proved in all the three genera of Ophioglossales ; yet no example of the axillary branch has been recorded so far in *Helminthostachys*. Figure 3 illustrates a case of an axillary branch formed and developed into an independent plant at some distance from the apex of the main rhizome of *Helminthostachys*. The axillary branch is about 6-7 years old while the axil at which it has developed on the rhizome is about 18

to 20 years old, judged on the basis of one leaf being produced each year by the plant and each leaf leaving behind a leaf-scar. While this branch has grown old enough to establish itself independent of the mother plant, another axillary branch is developing in the form of a small bud (Fig. 3 at A). This bud is situated on the main rhizome between the apex and the older axillary branch nearer to the axillary branch and has developed two to three roots. The main rhizome was perfectly normal when dug out of the soil, without any injury or damage from any cause.

"Jaya Nivas", L. N. Rao.
Gavipuram Extension,
Bangalore-19, *April* 9, 1960.

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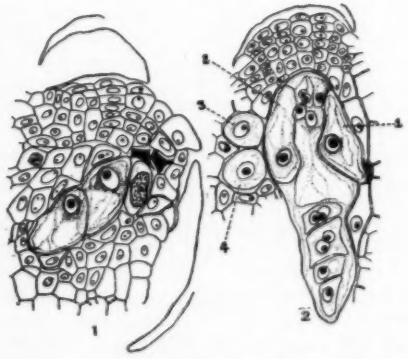
CYTOGENETIC INVESTIGATIONS IN PANICEAE: OCCURRENCE OF APOSPORY IN A DIPLOID SPECIES OF *PANICUM—PANICUM ANTIDOTALE* RETZ.

Apomixis appears to be common in Panicoideæ but it is confined mostly to polyploid species. However, cases of diploid species tending towards aposporous reproduction have been reported recently in *Pennisetum ramosum* $2n = 10$ by Narayan (1951).

Cytoembryological investigations of *Panicum antidotale* Retz. $2n = 18$ (Burton, 1942) have revealed that this species shows a tendency towards apomictic reproduction. In about five hundred ovules examined only two ovules showed the presence of multiple embryo-sacs suggestive of aposporous development. Figure 1



Figs. 1–2. *Panicum antidotale* Retz., × 1,552.

shows the presence of what appears to be three uninucleate embryo-sacs developed from nucellar cells. However, the two degenerating masses immediately above these embryo-sacs might suggest that two of the four megaspores of a linear tetrad might have degenerated and the other two have developed into these uninucleate embryo-sacs, the third cell being a nucellar cell developing into an aposporous embryo-sac. It is also possible that the two dark masses might be due to the degeneration of the two cells of the dyad in which case the two developing embryo-sacs would be nucellar in origin. But Fig. 2 clearly shows a well-organised embryo-sac with two very conspicuous uninucleate, enlarging cells marked 1 and 2 in Fig. 2 which appear to be potentially aposporous sacs. Two more nucellar cells also appear to be developing into aposporous embryo-sacs marked 3 and 4 in Fig. 2. In all probability the well-organised embryo-sac is haploid in origin and the aposporous-sacs appear to be aggressively encroaching upon this haploid sac. However, Brown and Emery (1958), working on the same species examining only 28 ovules, have reported a normal 'Polygonum' type of development of the embryo-sac in this species.

Further investigation is in progress.

Sincere thanks are due to Professor K. N. Narayan for guidance throughout this investigation and to the Systematic Botanist, Coimbatore, for identification of the plant. This work was carried out during the tenure of a Senior Research Training Scholarship awarded by the Government of India.

Dept. of Botany, K. Shama Kumari.
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Bangalore-1, *April* 21, 1960.

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A CASE OF TRIPLOIDY IN RAMIE

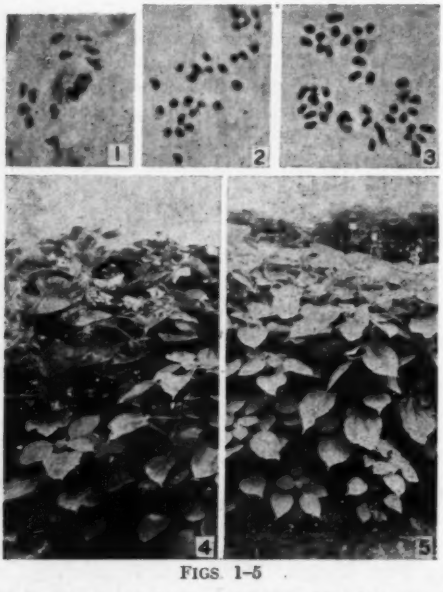
Ramie (*Bœhmeria nivea* Gaud), belonging to the family Urticaceæ, yields a very valuable stem fibre for which it is extensively cultivated in China, Japan, Philippines and certain other tropical countries of the world.[1] In India it is under cultivation in Assam and is being tried in West Bengal. More than 40 selections are under trial at Poona. Most of these flower normally and set viable seeds. Several, however, do not set seeds.

For the study of somatic chromosomes, root-tips were fixed in acetic alcohol (3 : 1) after

pretreating them for 2 hours in a saturated aqueous solution of *alpha*-bromonaphthalene at 10° C. The tips were thoroughly washed in water and then hydrolyzed in normal hydrochloric acid for 8 minutes at 60° C. and squashed in a drop of acetocarmine after having washed them again thoroughly in water. Meiosis in the pollen mother cells was studied by fixing the young flower-buds in Carnoy's fluid for 4 hours. The fixed anthers were squashed in a drop of acetocarmine.

The somatic chromosomes of *Bœhmeria nivea* Gaud are very short, varying from 2 to 2·5 microns in length. In the selections that set viable seeds, the somatic chromosome number was observed to be 28 (Fig. 2). This confirms the finding of Chatterjee and Bhattacharya.[2] Krause[3] has reported $2n = 28$ for *B. nivea*. Observations at metaphase I of meiosis gave $n = 14$ (Fig. 1).

The sterile selection I.R. 30 gave $2n = 42$ in the mitotic metaphase (Fig. 3). The presence of 42 somatic chromosomes in this type indicates its possible triploid nature. This appears to be the first case of triploidy recorded in this plant. Figures 4 and 5 show the diploid (selection



FIGS. 1–5

I.R. 44) and triploid (selection I.R. 30) ramie plants, of the same age, in the field respectively. Further investigations regarding the nature of triploidy and its relationship with flowering and seed-setting are in progress.

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A NEW SPECIES OF *SARCOPODIUM* ON COFFEE FROM INDIA

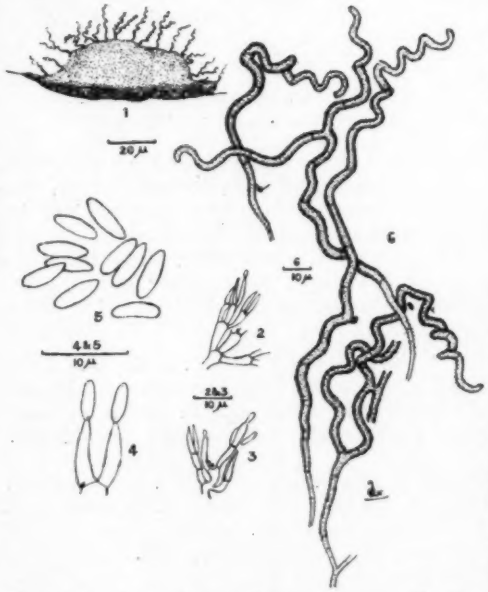
THE Dematiaceous fungus, for which a new specific name is proposed in this brief note, was first observed in September 1958, on living leaves of a single bush of *Coffea arabica* at the Coffee Research Station. It was again observed on the same bush in the current year. Only a limited number of leaves bearing the fructifications of the fungus were available on each occasion and the fungus was not observed on coffee bushes of the same variety growing a few feet away in the locality.

The fungus occurs on leaf-spots, which are irregularly oval to round, up to 3 cm. in diameter, brown, with occasional two to three zonate patches of varying width. The spot is delimited by a white, slightly effuse fringe composed of filaments of mycelium and a close examination with a hand-lens shows a characteristic presence of dendroid markings. This is easily discernible on the upper surface of the spot, extending outwards from a little behind the fringe before finally merging with it. The lower surface of the spot is of a lighter shade of brown than the upper surface. Fructifications of the fungus are found on both the surfaces of the spots. They are cæspitulose and interspersed with numerous flexuous, brown setæ which emerge well above the sporiferous layer. The conidia, borne on irregularly branched conidiophores, are hyaline, unicellular and cylindrical.

This fungus fits in the genus *Sarcopodium* Ehrenb. belonging to the Dematiaceæ of the Fungi Imperfecti. The geographical distribution of the nine species of *Sarcopodium* is very limited, their occurrence being confined to Europe, predominantly with rotting material as substrates.[1] Our fungus is unique in its occurrence on living leaves of coffee and does not agree with the description of the other known species. Dr. Ellis, who has examined this material, considers this as a new species. We, therefore, propose to accommodate this fungus as a new species named after the host plant.

Sarcopodium coffeanum N. sp.

Fructificationes cæspitulosæ, amphigenæ, superficiales, minutæ, usque ad 1 mm. diam. et 250 μ altæ, ovatæ, irregulares, nonnumquam confluentes, hemisphæricæ vel convexæ, lanatæ, primo albæ, tum carnosæ rubræ, circumdatæ setis plurimis brunneis. Conidiophori emergentes e serie tenui pseudostromatis, erecti, hyalini, septati, ramosi, ramis desinentibus in phialides. Phialides hyalinæ, continuæ, levibus parietibus præditæ, cylindricæ, aliquantum latæ ad basim, gradatim fastigatæ ad apicem, magnitudine media 11·8 × 1·8 μ (8·4–16·8 × 1·4–2·1 μ). Setæ erectæ, emergentes ut rami laterales steriles conidiophororum, angustæ, tenuibus parietibus parædítæ ad apicem remotum, latæ et crassis parietibus præditæ ad medium, longæ, septatæ, simplices vel ramosæ, spiraliter curvatæ supra,



FIGS. 1–6. *Sarcopodium coffeanum* sp. nov. Fig. 1. Section of the cæspitulose fructification of the fungus. Figs. 2–3. Branching habit of the conidiophore. Fig. 4. Ultimate branches of the conidiophore bearing conidia. Fig. 5. Conidia. Fig. 6. Simple and branching sterile setæ.

nonnumquam anastomosantes inter se, circumdatæ verruculis densis, fusce brunneae, 2·5–3·5 μ ad punctum latissimum. Conidia acrogene insidentia, singula et successive phialidibus, hyalina, unicellularia, tenuia et levia, cylindrica, guttulata, magnitudine media 5·7 × 1·7 μ (5·2–6·5 × 1·4–2·1 μ).

Typus lectus in foliis *Coffeæ arabicæ* e familia Rubiacearum, ad Coffee Research Station, Balehonnur, India, die 11 septembris anni 1958, a T. R. Nag Raj, et positus in Herbario Commonwealth Mycological Institute, in Anglia sub numero IMI 76594.

The fungus could be readily isolated in pure culture on potato-dextrose agar, but failed to sporulate even after six months of incubation at room temperature, while on yeast-extract agar scant sporulation was observed after two to three months.

We are much grateful to Dr. Ellis, Assistant Mycologist, Commonwealth Mycological Institute, England, for examination and identification of the herbarium material; to Dr. B. T. Narayanan, former Director of Research, for encouragement; and to Rev. Fr. Dr. H. Santapau, S.J., St. Xavier's College, Bombay, for kindly rendering the Latin diagnosis.

Coffee Research Station, Balehonnur (India), *December* 24, 1959.

T. R. NAG RAJ.
K. V. GEORGE.

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RELATIONSHIP BETWEEN MILK PRODUCTION AND CERTAIN BODY MEASUREMENTS IN MURRAH BUFFALOES

PHILLIP[2] carried out a detailed study on the relation between form and production in dairy cattle, yet very little information is available on buffaloes.[1,5] In India, farmers select buffaloes on the type, for the production records are rarely available. The experiment, therefore, reported here, refers to the relationship between some body measurements and milk production which may help us in selecting buffaloes for higher milk yield.

Twenty-four Murrah buffaloes constituted the experimental material, 9 in second lactation, 12 in third lactation and 3 in fourth lactation. The previous lactation record of these animals were taken into account after correcting for the days of lactation.

Each animal was measured for body length, heart girth, abdominal girth and length of tail thrice on one day only without making any reference to previous observations. The measurements used for the final assessment of the analysis is the mean of the three readings for each character considered. The body weight was calculated by the formula,

$$\text{Body weight (lb.)} = \frac{(\text{Heart girth}'')^2 \times \text{Length}''}{300}.$$

Repeatability,[4] correlation and regression coefficients[3] were calculated.

TABLE I

Mean, variance, standard deviation and coefficient of variation of different measurements and milk yield

Character	Mean	Variance	S.D.	% of coefficient of variation
Body length (in inches)	61·16	4·14	2·03	3·31
Heart girth ,,	75·50	9·21	3·03	4·01
Abdominal girth ,,	83·54	12·95	3·59	4·29
Tail length ,,	37·25	12·19	3·49	9·36
Body weight (in lb.)	1170·20	12708·69	112·73	9·63
Milk yield ,,	3158·62	5678·85	74·22	2·36

Table I indicates the mean, variance, standard deviation and percentage of coefficient of variation for body length, heart girth, abdominal girth, tail length, body weight and milk yield of the population of randomly selected buffaloes under study.

TABLE II

Analysis of variance

Source	d.f.	M S. (Body length)	M.S. (Heart girth)	M.S. (Abd. girth)	M.S. (Tail length)
Between animals	23	9·14*	24·66*	37·32*	25·02*
Between observation	2	0·60	0·51	0·06	1·68
Remainder	46	0·78	0·32	0·73	1·03

* Significant at 1% level.

Results in Table II indicate highly significant differences between animals for the body length, heart girth, abdominal girth and tail length, which promote a confidence in us that selection of Murrah buffaloes can be practised on the body size. Repeatability for body length, heart girth, abdominal girth and tail length has been calculated to be, 0·77, 0·96, 0·94 and 0·92 respectively.

Figure 1 indicates that : (i) There exists significant correlations between and amongst body length, heart girth, abdominal grith, body weight and milk yield ; (ii) There is no correlation between length of tail and other characteristics measured.

The regression coefficients of milk yield on body weight, body length, heart girth and abdominal girth are $0·307 \pm 0·126$, $18·20 \pm 6·8$, $12·17 \pm 2·5$, and $7·8 \pm 2·3$ respectively. These values are significant.

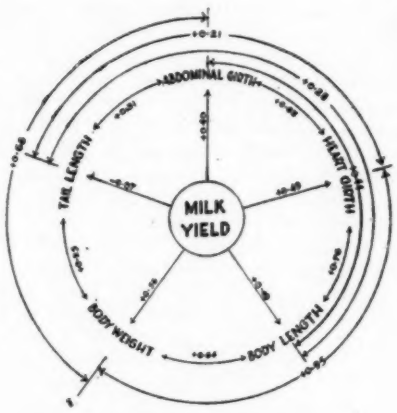

FIG. 1. Showing correlation coefficients.
$P_{(22)}5\% = 0·40$; $P_{(22)}1\% = 0·51$.

It has been calculated that for every 100 lb. increase over 1170·20 lb. of body weight, there is an increase of 30·7 lb. of milk per lactation, and also milk production increases by 18·2, 12·1 and 7·8 lb. per lactation for an increase of 1" over each of 61·16" body length, 75·50" heart girth and 83·54" abdominal girth respectively.

Thanks are due to Shri R. L. Kaushal, Principal and Joint Director, Research, for his keen interest and encouragement shown at all the time during the course of this investigation.

College of Vet. Sci. and Animal Husbandry *cum*-Livestock Res. Inst., Mhow (M.P.), *January* 14, 1960.

D. S. BHATNAGAR.
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THE EFFECT OF THE 'BLACK-TIP' DISEASE ON THE CATALASE AND PEROXIDASE ACTIVITY OF THE MANGO FRUIT

THIS note describes the effect of the black-tip disease[1] on the catalase and peroxidase activity of seven to eight-week old fruits of 'malihabadi safeda', 'tamboori' and 'dasehri' varieties of mangoes collected from near Lucknow. The catalase and peroxidase activities of the upper (proximal 2/3) and the apical (diseased or its corresponding) parts of the healthy fruits, types H I and H II, and diseased fruits, types N I and N II, were measured by the manometric[2] and purpurogallin[3] methods respectively and the mean values are given in Figs. 1 and 2.

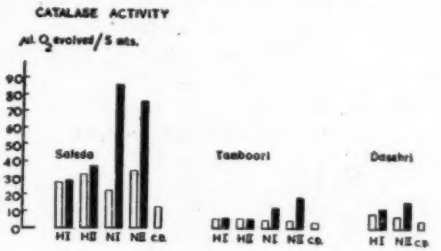

FIG. 1

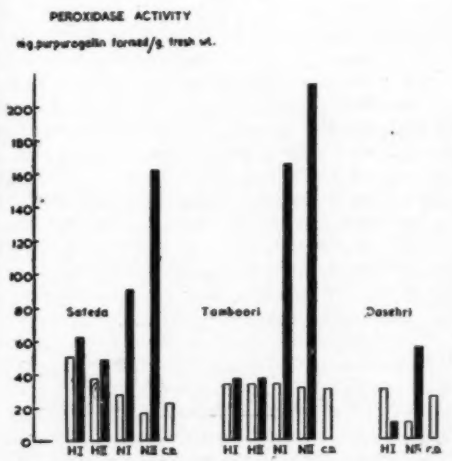

FIG. 2

FIGS. 1–2. The shaded and the unshaded columns respectively refer to the apical and upper parts of fruits. H I refers to fruits from healthy trees, H II to healthy fruits from diseased trees, N I to fruits showing necrosis of the extreme apical end, and N II to diseased fruits of advanced stage of necrosis.

In general, while the peroxidase activity of the three varieties of mangoes studied was of almost the same order, the catalase activity of the 'tamboori' and 'dasehri' varieties of mangoes was appreciably lower than that of the 'safeda' variety.

In the diseased fruits, of all the three varieties studied, a markedly and significantly higher activity of catalase and peroxidase was found in the apical part than in the upper part. No significant difference in the activity of the two enzymes was found in the upper and the apical parts of the healthy fruits.

Generally the upper part of the different types of fruits of the 'safeda', 'tamboori' and 'dasehri' varieties did not show significant difference in the activity of the two enzymes but in all the three varieties the apical part of the diseased fruits had a markedly and significantly higher activity of catalase and peroxidase than the corresponding part of the healthy fruits. The activity of catalase in the 'tamboori' variety and of peroxidase in both 'safeda' and 'tamboori' varieties was significantly higher in the apical part of the N II type of fruits than in the N I type.

The above observations show that, as in the case of tannins, carbohydrates and total titrable acids[4] and ascorbic acid,[5] the effect of the black-tip disease on the two iron-porphyrin enzymes, catalase and peroxidase, is largely confined to the apical (necrotic) part of the mango fruits; the increase in the enzyme activity appears to be related to the severity of the disease (necrosis). Increase in the activity of the two enzymes would suggest either an enhanced rate of synthesis of these enzymes in the diseased tissue or the destruction in the diseased tissue of some inhibitors, normally present in the healthy fruits.

Dept. of Botany,
Lucknow University,
Lucknow,
January 27, 1960.

S. C. AGARWALA.
C. P. SHARMA.
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REVIEWS

Geology of the Country around Polonnaruwa. By P. W. Vitanage. Memoir No. 1. Geological Survey of Ceylon. (Government Press, Colombo, Ceylon), 1959. Quarto 75 pp., 11 figs. 12 pls. including a coloured geological map.

The memoir is a description of the geology of sheet 47 (between latitudes 7° 50′ and 8° 06′ and longitudes 80° 43′ to 81° 07′) which is given as a coloured geological map on the scale of 1" 1 mile. It is near the centre of Ceylon, in the N.E. quadrant. The formations are Pre-Cambrian metamorphics comprising gneisses of the Vijayan series, Charnockites, Khondalites, Calc-granulites quartzites, etc. Most of the latter occur as thin narrow bands with a nearly N.-S. strike and moderate westerly dip. A small pitching fold is seen in the north-west part of the map. The various rock types are described in detail and a chapter is devoted to the structure of the area.

The paper contains some 16 analyses of gneissic rocks, several analyses of limestones and of some ground-waters. There is a chapter on economic geology dealing with water resources, limestones and other useful types of stones. The memoir bears evidence of careful field and laboratory work in the elucidation of the geology and structure of the area studied. It constitutes a fairly exhaustive study of a typical area in Ceylon and is to be welcomed as the first detailed description of this chapter published by the Government Geological Survey of Ceylon.

M. S. KRISHNAN.

Electrolytic Manufacture of Chemicals from Salt. By D. W. F. Hardie. (Published under the auspices of the Imperial Chemical Industries, Oxford University Press, Madras-2), 1959. Pp. xii + 73. Price Rs. 6·00.

This is one of the text-books sponsored by the I.C.I., written with the object of bridging the gap between "the chemistry learned at school and the chemistry as applied in industrial practice". Chemistry as a science and the teaching of it, would be much more interesting in the class-room if the gap referred to is judiciously bridged. The discipline of chemistry would be more strongly imprinted. Dr. Hardie has performed a difficult task admirably well. In eight small chapters, covered in 74 pages, he has dealt with every aspect of the important industry. The theoretical basis of the industry, the preparation of the raw materials, the different electrolytic cells for alkali-chlorine as well as metallic sodium, the manufacture of hypochlorite and chlorate, the properties and uses of the various products, production statistics, etc., have all been comprehensively and succinctly presented in a way that has rendered reading pleasant and profitable. There is an appendix giving the chronology of the development of the industry. This is a book that should be read by every student preparing for a degree in chemistry in this country.

A. N. KAPPANNA.

Semimicro Experiments in General Chemistry and Qualitative Analysis. By N. D. Cheronis and H. Stein. (John De Graff Inc., 31 East 10th Street, New York-3, N.Y.), 1959. Pp. x + 310.

This laboratory text gives a complete year's practical course in General Chemistry using small-scale equipment and techniques. Semimicro methods, at least in qualitative Inorganic Analysis, have come to stay in most of the Western countries and a number of laboratories in India have started employing these techniques. Besides the economy in materials, the saving in time and labour, and smaller requirement of space in the laboratory—semimicro methods enforce upon the students greater discipline as to care, cleanliness and manipulation—a training which is bound to help them in life.

The book is divided into two parts: Part I consists of 30 chapters and includes 115 laboratory exercises in General Chemistry and Part II consists of 8 chapters on theory and exercises in Qualitative Inorganic Analysis.

The book will be of great value to teachers and demonstrators in guiding first year university students in their practical work.

Experiments and Exercises in Physical Science. By Robert Maurer and Konrad B. Krauskopf. (McGraw-Hill Book Co., Inc., New York-36, N.Y.), 1959. Pp. 180. Price $ 2.95.

This beginners' manual in practical science is keyed to the text-book by Konrad B. Krauskopf, *Fundamentals of Physical Science*, and contains 40 exercises, which include besides the

routine experiments such topics as "The north circumpolar constellations", "Sunspots", "Variable stars", "Behaviour of gases", "The periodic law", "Spectra", "Ions", "Weathermaps", "Rocks", "Stream erosion". The manual if diligently used will make the study of science more interesting to the beginner and help him to intelligently understand the physical world about him.

Blood-Groups—*British Medical Bulletin*, Vol. 15, No. 2. (The Medical Department, The British Council, 65 Davies Street, London W. 1), May 1959. Pp. 89-173. Price 20 *sh.*

The British Medical Bulletin, Vol. 15, No. 2, May 1959, contains articles on the *Blood-Groups* —a report on the Symposium presided over by Dr. A. E. Mourant. There are fourteen articles on various aspects of blood-grouping. The one contributed by W. T. J. Morgan and W. M. Watkins, the third of the series, deals with the biochemistry of human blood-group substances. In this article the isolation, properties, structural studies and the serologically active groups have been considered. Purification and isolation methods have been briefly given. The difficulty of establishing the homogeneity of isolated substances especially in human A, B, H, Le^a substances (which show no evidence of heterogeneity under ordinary circumstances, and yet are not single substances) indicates that the problem is not wholly solved. Mild methods have been employed in understanding structural aspects. Serological methods have also been used for identification. These experiments indicate that the specificity of these blood-groups substances resides in the carbohydrate portions of the associated mucopolysaccharides. At the various portions of the molecule the 'galactosyl' —or the 'fucosyl'—etc., units, are associated with specificity, whereas the amino-acid part is probably not employed for the specific dominant structure.

On the various other articles in the Symposium, a detailed review cannot be made as each one of them is a study by itself. Attention, however, is drawn to the 12th article on the absorption of blood-group substances on to red cells by the Sneaths; (of topical interest in the studies of Hæmogglutuation Influenzal Studies). Notice has also to be taken of hæmogglutinins available in seeds, specially against the A, B, H, and N blood-groups.

C. V. NATARAJAN.

Current Virus Research. *British Medical Bulletin*, Vol. 15, No. 3. (Medical Department of the British Council, London), 1959. Pp. 175-250. Price 20 *sh.*

Virology is a rapidly expanding field of study. The cultivation of trachoma virus has opened up new pathways for understanding the epidemiology of this intractable disease and for chemotherapeutic trials of new drugs. Technical advances in tissue culture has rendered quantitative serological study, relatively an easy affair and has enabled the isolation of numerous new viruses—aderoviruses, enteroviruses, respiratory viruses and many arboviruses. Agal gel diffusion, use of fluorescent antibodies, cytochemical techniques, electron microscopy, biochemical and radio isotope studies are enhancing our knowledge of the virus metabolism and the host-parasite relationship. The discovery of 'interferon', possibly a protein, mediating in the growth inhibition of one virus over another is a development, full of potentialities for a rationale approach to the success of viral chemotherapy. This volume presents the advances in these topics besides briefly referring to the related virological aspects of Myxamatosis, the common cold, chicken pox and measles.

M. SIRSI.

Antibiotics Therapy for Staphylococcal Diseases. Edited by Henry Welch and Maxwell Finland, Antibiotics Monographs No. 12. (Medical Encyclopedia, Inc., New York; Distributors outside U.S.A.: Interscience Publishers, New York and London), 1959. Pp. xii + 208. Price $ 4.50.

The staphylococcal disease problem has now come up 'plaguing the entire medical profession', as a result of the revolt of these microbes against the massacar of the antibiotics, and strangely enough has begun to tell on what we consider to be achievements in our medical organisation. "Within the past year certain hospitals in this country have closed their obstetrical services and nurseries because of uncontrollable staphylococcal infections; other hospitals send mothers and their new babies home as rapidly as possible to avoid infections." The present monograph deals with this problem and the way it could be tackled with the antibiotics available.

Welch in the first chapter gives a lucid survey of the problem, and deals with the use of penicillin, chloramphenicol, tetracyclines and bacitracin in detail. In the six chapters following,

erythromycin, oleandromycin, novobiocin, vancomycin, ristocetin and kanamycin, are dealt with by the authorities in the subject. Though some unevenness is observed in the presentation, these chapters contain almost everything relevant about these antibiotics which are of interest to the research workers and the physicians. The structures of kanamycin and streptomycin might have been presented in a more pleasing form to match the fine get-up and printing of this monograph. The formula of erythromycin is a glaring omission particularly because its elucidation is a great achievement. The last chapter deals briefly with tyrothricin, sulfonamide drugs, carbomycin and spiramycin, streptogramin, leucomycin and bryamycin, and compares all the antibiotics in their use for staphylococcal infections. It is enough that the physician has a potent antibiotic in hand; it has to be used in the right case and in the right way, to get the maximum out of it. "Some physicians may extract the most value from relatively poor agents by applying them properly and to their best advantage, whereas others may have less success in the application of more potent agents by using them improperly." The foreword of Felix Marti-Ibanez is thereto turn to as a relaxation from the mass of facts. "It is the fate of each new advance in medical science at once to solve old problems and create new ones.....Every time in history the physician makes a great discovery, he seems condemned to pay a price for his achievement by having to face new dangers unleashed by such discovery". A world without diseases would be an awfully dull phenomena to the medical investigators, since we have not yet switched on to investigate the conditions of the healthy! This monograph is indeed a very valuable addition to the series.

K. GANAPATHI.

Sulfur in Proteins—Proceedings of a Symposium held at Falmouth, Massachusetts, May 1958. Edited by R. Benesch, R. E. Benesch, P. D. Boyer, I. M. Klotz and others. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1959. Pp. xi + 469. Price $ 14.00.

The book under review is a publication of the proceedings of a symposium held at Massachusetts in 1958, on the unique and significant role played by the thiol or the disulfide group in influencing the properties and behaviour of several proteins. Many eminent and active workers in this field of protein structure and protein modification have participated in this symposium. Hence the papers presented and the details of the proceedings and discussion constitute a very valuable record of the present state of knowledge on this subject.

The book has been divided into eight sections. The first among these concerns itself with protein reactions involving sulfur. The paper by Swan on the reaction of proteins with sulfite to form S-sulfoproteins falls in this section. This method has now found considerable favour among protein chemists and its utility lies in the fact that water-soluble modified proteins can be obtained under relatively mild conditions. Another interesting article in this section is that of Benesch and Benesch on the *de novo* introduction of thiol groups using thiolactones as the thiolating agents. This method should prove of extreme value in studying the activity—structure relationship of biologically or enzymatically active proteins. The other three papers dealt with the optical rotation of proteins after treatment with reagents that modify the S-S-group, reactivity of wool cystine and the isolation of a high-sulfur containing protein from wool.

The second section deals with the properties and role of SH groups in serum proteins. Jensen's experiments on the chemical reactivity of the SH group in bovine plasma albumin leads to the conclusion that the reversible—but stable—intramolecular association of the albumin sulphydryl group explains a number of its unusual properties. The evidence though strong is not, however, conclusive enough. This is followed by a mathematical treatment on the probability of isomers in cystine containing randomly coiled polypeptides by Walter Kauzmann. Lorand and co-workers have presented an extremely interesting article on the clotting of blood plasma; they have shown that under the enzymic influence of thrombin and in the presence of Ca^{++}, the copolymerisation of fibrinogen and fibrin stabilizing factor leads to clot formation. Evidence is presented for the essentiality of SH groups in the latter for biological activity.

In Section III, five articles pertaining to the role of sulfur in metalloproteins have been presented. The arguments cited by Klotz and Klotz clearly show that the metal proteins should prove as convenient systems for the correlation of biological specificity and molecular architecture. This is followed by an excellent paper of Hans Tuppy on the digestion, isolation of hæme peptides from tryptic digests of cytochrome C and on the constancy of basic structures in cytochrome C. The next three papers

deal with (i) cystine/cysteine content of hemoglobins, (ii) sulphydryl groups and the oxygenation of hemoglobin and (iii) relation of iron to sulphydryl groups in ferritin.

The role of SH groups in the enzymatic activity of some proteins is the subject-matter of part IV of this monograph. The enzymes studied are alcohol dehydrogenases, beta-galactosidase and ribonuclease. White and Anfinsen have described a method for following the reduction of specific disulphide bonds in ribonuclease and have indicated the utility of this method for the correlation between reduction and enzymatic activity.

Section V concerns itself with the function and role of sulfur in muscle proteins and in the reactivities of muscle protein fractions. The last two sections deal with the importance of sulfur in virtuses and cell division. The monograph concludes with a lucid summary by Prof. Edsall.

In essence, therefore, this book brings together an account of the variety of functions, which sulfur plays in protein structure as well as in enzymatic activity. In the reviewer's opinion, the main objective which is "to help in the considered appraisal of related findings in the development of productive research", in so far as the role of sulfur in proteins is concerned, has been fully realised by this timely publication.

P. S. SARMA.

Human Nutrition and Dietetics. By Sir Stanley Davidson, A. P. Meikeljohn and R. Passmore. (Publishers E. & S. Livingstone Ltd., Edinburgh and London), 1959. Pp. xx + 844. Price 84 *sh.*

The subject-matter has been presented in six parts, the first three of which deal with physiology of nutrition, food and its characteristics and nutritional disease respectively. The second half of the book is concerned with dietetics in disease and other applied aspects of nutritions such as its role in public health and the influence of stress factors on diet and nutrition.

The authors have drawn extensively on individual personal experience in their respective fields. This has resulted in imparting a personal touch to the presentation, which makes the book eminently readable. One feature of the book which needs special mention is the recognition given to work done in nutrition in the tropics. This is particularly gratifying for very often text-books of physiology and nutrition contain information based only on knowledge and experience gained in the laboratories in the temperate zone completely ignoring the fact that different climate, dietetic and other environmental conditions existing in the tropics evoke phenomena of adaptation an appreciation of which should improve our understanding of human physiology and nutrition. The authors are to be congratulated on their attempts to rectify the situation. It is hoped that their example will stimulate other prospective authors in presenting a more complete account of the subject than they have been doing thus far.

The book should be of great interest to students of nutrition and dietetics and to physicians interested in improving their knowledge of dietary management of diseases. The style of writing is lucid without being dull, at times it may even be said to be provocative. There are some minor points, however, on which there could be disagreement. The printing is excellent, printing errors being commendably few considering the large size of the book. The reviewer has no hesitation to state that the book should be a valuable and essential addition to the libraries of medical teaching institutions and of laboratories interested in nutrition.

V. N. PATWARDHAN.

Perfumes, Cosmetics and Soaps. By W. A. Poucher. Volume 1, Raw Materials. Sixth Edition Revised. (Chapman and Hall, London), 1959. Pp. xvi + 463. Price 75 *sh.*

The Name Poucher spells magic in the perfumery world, particularly the English-speaking part of it. And, the appearance of a new Edition of the "Standard" work by this doyen of the British Perfumery profession is no less than an event.

The usefulness and consequent popularity of Poucher's treatise are due first to the comprehensiveness of the data presented on perfumery raw materials—their sources, methods of production, utilisation, adulterants, trade customs and usage ; and, equally, to a large number of basic formulæ which can well form the alphabet of the practising perfumer's science and, yes, art. These formulæ serve as tried starting points for further experimentation, revision and adoption enabling the skilled perfumer to create a harvest of new perfumes of bewildering variety but each with a cachet and personality of its own.

It would be little short of a miracle if in such a Dictionary covering the whole world and including within its ambit raw materials of vegetable, animal and synthetic origin, all the entries were of the same level of accuracy and

excellence. Thus, for example, the author's treatment of "Lavender" is masterly; at the other end is "Sandalwood oil El" under which an English periodical is cited for the statement that "The (Sandal) trees are felled between the ages of 18 and 25 years!" And, that "the felled trunks are left lying on the ground for several months so that they may be attacked by white ants". Both these statements are not correct. In general, the treatment accorded to Essential Oils and perfumery materials of Indian origin tends to be out of date bordering occasionally on the obsolete.

The title of the volume carries the descriptive sub-head "with special reference to synthetics". It is therefore a little surprising that the volume does not include even a passing reference to detergents whose development during the last decade can only be described as phenomenal. Nor does that versatile cosmetic chemical, sorbitol, find an entry. It would be appropriate and add to the comprehensiveness of the volume if these as well as the main types of surface active agents and emulsifiers get at least an indicative reference.

This Dictionary, like all good dictionaries, provides delightful reading even apart from its technical excellence. How many would know that valuable Indian Shawls were distinguished by their odour of Patchouli? Or, that the hapless musk deer is lured to its destruction by music? Or, the story behind the name "Frangipanni"? The book is studded with many such delicious vignettes. It is obvious that for this distinguished author, his work is his love.

The volume carries 50 illustrations, 47 of them photographs. Even so, a price of 75 shillings would appear in India to be on the high side. But, then, the Perfumery, Cosmetic and Soap industries are "Luxury business" and can pay for what they want. And, anyone connected in anyway with the raw materials of these industries is sure to get what he wants in this book.

M. N. RAMASWAMY.
M. N. SUBBA RAO.

Cultural Trials and Practices of Rice in India. By M. Subbia Pillai. (ICAR Monograph No. 27), 1959. Pp. ii + 166. Price Rs. 7·75.

This is a monograph complementary to the volumes "Rice in India" and "Rice Manuring in India" already published by the ICAR. It summarizes the results of agronomical and cultural experiments done on rice so that it can serve as a handbook for extension workers. The monograph is divided into 2 parts and Part I with 9 chapters describes the cultural practices under preparation of the land, seeding of the land after cultivation, harvesting, threshing, implements, rotations, etc., and the results of various experiments done on them in different research stations of India. It is found that the experimental data are much more comprehensive and extensive in some States such as Madras, Andhra and Bombay than in others indicating the necessity for more experimental work in them.

Part II which summarises the information for the use of extension workers can be considered the more important part of the book. This part also includes information on the improved varieties recommended for cultivation in different rice areas of the States. This information must however be considered not sufficiently critical as the number of varieties actually in cultivation is at present much more limited than what has been indicated in the book.

It is known that manurial experiments and variety trials conducted at research stations can only be taken as indications and have to be extended to cultivators' fields. The same may also apply to cultural trials but not to the same extent. This will be evident from the information provided in the book that cultural practices followed are much more uniform over a wide area in different parts of India although soil and climatic conditions and varieties grown very considerably. It has also to be remembered that such cultural practices as the method of raising seed-beds, the age of seedlings to be planted, the optimum spacing, etc., are more or less dependent on the variations in season, soil fertility and variety. Small adjustments of these cultural practices suited to local conditions are no doubt familiar to experienced farmers. It is possible, however, that with more intensive cultivation of the crop the practices that are considered optimum at present may have to undergo a change. It would be seen that there is considerable lacuna of information about some of the cultural practices as for example the most satisfactory initial cultivation of land and the time and quantity of water to be given for obtaining maximum production.

Mr. M. Subbiah Pillai who has considerable experience as a rice agronomist both in Madras and in Orissa has made a good job of the work he was entrusted with and the book can be safely recommended as a useful reference book for all rice agronomists.

K. R.

A Guide to Antibiotic Therapy. By Henry Welch. (Medical Encyclopedia, Inc., New York; Distributors outside U.S.A.: Interscience Publishers, New York), 1959. Pp. 69. Price $ 3.00.

In this guide is tersely condensed in scientific shorthand all the data and knowledge available about 31 antibiotics which constitute a simple, practical tool of great clinical importance for the practising physicians. General indications, side effects, major dosage form(s), average daily dose, the blood and urine concentrations to be anticipated, and the *in vitro* susceptibility of each group of important pathogenic micro-organisms to each antibiotic, are given.

The antibiotics are dealt with in an alphabetical order, each being assigned two pages; there is enough space for one to add on, when more data become available. The value of this guide is in its conciseness, and the authority behind it. Though in our country we do not use more than a third of the number of antibiotics, this guide should be an indispensable companion to all the physicians in the place of the material supplied by the interested pharmaceutical houses, "in choosing the right drug, the right dose and the right way to administer it as to ensure its maximum curative efficacy". The reviewer would add a personal note that what is achieved in this guide is what he attempted a number of times and could not complete.

K. Ganapathi.

The Application of Genetics to Cotton Improvement. By Sir Joseph Hutchinson. (Cambridge University Press), 1959. Pp. 87. Price 15 *sh.*

Sir Joseph Hutchinson has written an extraordinarily remarkable treatise on cotton as it contains a distilled account of the work done on the origin and the evolution of our commercial cottons. He has ably shown that all commercial cottons of the present day have been derived from four wild species. He has discussed the breeding technique which has undergone remarkable changes during last 25 years. The application of genetic principles to cotton breeding was undertaken at Indore in the Central India in 1933 when Sir Joseph had taken up an appointment at Indore and it replaced the pure line concept which dominated the plant breeding work in India in those years. The genetic principles and the statistical methods were later further developed by other workers. The present-day very fine and long stapled annual cotton have thus been evolved from a coarse short perennial cotton grown about 4,000 years ago in Africa. Many strains resistant to jassids and other diseases have then been evolved by the application of genetic principles in the breeding work.

Recently the importance of physiological studies has been realised in cotton improvement programme as a cotton fitted to a particular environment can be determined by physiological studies only. Sir Joseph has quoted an instance where such studies led to an assessment of the relation between planting date and the crop yield and further led to the study of the rainfall regime of the Uganda cotton and later the water requirements of the crop and the relation of crop size and the rainfall. Thus a physiological specification for a cotton that would give high yield has been derived. That physiological specification appeared to be a plant with long vegetative period so that enough food may be stored up when the leaf area was not limited by the soil moisture and these reserves may then be available when the leaf-area soil-moisture relationship becomes critical.

The book will surely prove a valuable guide to those engaged in cotton improvement. It is written in a lucid style and can be read without difficulty.

R. H. Dastur.

Books Received

Advances in Spectroscopy. Edited by H. W. Thompson, Vol. 1. (Interscience Publishers, New York), 1959. Pp. x + 363. Price $ 12.50.

Physics of the Atom. By M. Russell Wehr and James A. Richards Jr. (Addison-Wesley Publishing Co., Inc., Reading, Mass., U.S.A.), 1960. Pp. xii + 420. Price $ 6.50.

Turbulent Transfer in the Lower Atmosphere. By C. H. B. Priestley. (Cambridge University Press, London N.W. 1), 1959. Pp. viii + 130. Price 28 *sh.*

Zygnemaceæ. By M. S. Randhawa. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. 478. Price Rs. 26·00.

Cyanophyta. By T. V. Desikachary. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. x + 686. Price Rs. 37·00.

Window in the Sky. By Homer E. Newell Jr. (McGraw-Hill Book Co., New York-36), 1959. Pp. 118. Price $ 2.75.

Biennial Review of Anthropology. Edited by Bernard J. Siegel. (Stanford University Press, California), 1959. Pp. x + 273. Price $ 6.00.

De Magnete. By William Gilbert. (Dover Publications, New York-14), 1959. Pp. liv + 368. Price $ 2.00.

Confluent Hypergeometric Functions. By L. J. Slater. (Cambridge University Press, London, N.W. 1), 1960. Pp. ix + 247. Price 65 *sh.*

Electrical Circuit Analysis. By K. Stephen. (Clever-Hume Press Ltd., London), 1959. Pp. 259. Price 30 *sh.*

Non-Benzenoid Aromatic Compounds. Edited by David Ginsburg. (Interscience Publishers, New York), 1959. Pp. xii + 543. Price $ 18.00.

From Magic to Science. By Charles Singer. (Dover Publications, New York-14), 1959, Pp. xxxi + 253, Price $ 2.00.

Physical Methods of Investigating Textiles. Edited by R. Meredith and J. W. S. Hearle. (Interscience Publishers, New York), 1959. Pp. x + 411. Price $ 13.00.

The Correspondence of Isaac Newton. Vol. 1 (1661-75). Edited By H. W. Turnbull. (Cambridge University Press, London), 1960. Pp. xxxvii + 467. Price £ 7·7 *sh.*

Modern Co-ordination Chemistry—Principles and Methods. Edited by J. Lewis and R. G. Wilkins. (Interscience Publishers, New York), 1960. Pp. xvi + 487. Price $ 12.50.

The Development and the Embryonic Anatomy of the Human Gastro Intestinal Tract. By Niels Lauge-Hansen. (Centrex Publishing Co., Eindhoven), 1960. Pp. viii + 86.

SCIENCE NOTES AND NEWS

Institution of Chemists (India): Associateship Examination, 1961

The Eleventh Associateship Examination of the Institution of Chemists (India) will be held in November 1961. The last date for Registration is 30th November 1960. The Examination in Group A (Analytical Chemistry) is divided into the following ten sections and each candidate will be examined in two of them according to his choice as approved by the Council, in addition to the General Chemistry including Organic, Inorganic, Physical and Applied Analytical Chemistry: (1) Analysis of Minerals, Silicates, Ores and Alloys; (2) Analysis of Drugs and Pharmaceuticals; (3) Analysis of Foods; (4) Analysis of Water and Sewage; (5) Biochemical Analysis; (6) Analysis of Oils, Fats and Soaps; (7) Fuel and Gas Analysis; (8) Analysis of Soils and Fertilisers; (9) Analysis connected with Forensic Chemistry; and (10) Analysis connected with Leather Chemistry. The Examination is recognised by the Government of India as equivalent to M.Sc. in Chemistry for purposes of recruitment of Chemists.

Further enquiries may be made to the Honorary Secretaries, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

The Agricultural Society, Calcutta

At the Annual General Meeting of the Society held on 6th April 1960 the following Office-bearers were elected for the year 1960: President—Dr. J. N. Mukherjee, Vice-President—Sri. Bimal Chandra Sinha, Editor—Dr. P. K. Sen, Secretary-*cum*-Treasurer—Sri. R. M. Datta.

Russian Journal of Physical Chemistry

The Chemical Society of London has announced the publication of the *Russian Journal of Physical Chemistry* (*Zhurnal Fizcheskoi Khimii*), starting from the Russian July 1959 issue. The publication is brought out with the support of the Department of Scientific and Industrial Research. The cover-to-cover translation is issued in monthly parts and is scheduled to appear about three months after the Russian original. Mr. R. P. Bell, F.R.S., is the Scientfic Editor of the Translation Journal. The annual subscription is £ 30 or $ 90 with a 25 per cent. reduction for Colleges and Universities. Single copy is priced at £ 4 or $ 12. The world distributors of the Journal are Cleaver-Hume Press Ltd., 31, Wright's Lane, London, W. 8.

The first issue (Russian July 1959) that has come for review contains in its 108 pages 37 original contributions so varied in scope that there is something to interest almost every type of chemist. The translations are accurate and the printing and get-up are attractive.

Conference on Building Materials

The Second Research Workers Conference on Building Materials was held at the Central Building Research Institute, Roorkee, from 11-13th April, 1960.

The Conference was attended by about forty delegates from Research Institutes in the country and representatives of the building industry. The deliberations of the Conference were conducted in seven Sessions: Heavy Clay Products; Cementitious Materials; Concrete; Heat and Sound Insulation; Paints and Painting; Organic Building Materials and Dissemination of Results of Research.

Inaugurating the Conference, General Sir H. Williams, Director, Central Building Research Institute, emphasised the role of the building materials industry and research in meeting the demands of the Third Plan. Thereafter Discussion Leaders appointed for different Sessions, reviewed the present state of knowledge in their respective fields highlighting those problems that still require a solution. This was followed by a general discussion of the thirty papers and a final round-up by the respective Chairmen.

Sputnik III Disintegrates

On April 6, 1960, the third Soviet Sputnik, launched on May 15, 1958, entered the dense layers of the atmosphere and ceased to exist.

The Sputnik had been aloft for 691 days, covering over 448 million kilometres during the period.

The last radio signals from the Third Sputnik were picked up by observation stations on the territory of the Soviet Union on the morning of April 6, when it was making its 10,035th orbit, and were registered till it left the zone of visibility of the Soviet observation network.

According to calculations and the data of the last observations made in the Western hemisphere, the Sputnik ceased its existence on the 10,037th circuit when its orbiting time was about 87 minutes.

Sputnik III completed its 5,000th revolution on May 8, 1959, after it had been in flight for 358 days, and had covered about 228 million kilometres. By that time its period had diminished to 99·51 minutes from the initial period of 105·95 minutes.—*USSR News.*

Ultrasonic Flowmeters

Ultrasonic flowmeters, probably for rockets, have been made to operate successfully in measuring high rates of flow such, for example, as 100 ft. a second. For industrial purposes a rate as low as 5 ft./sec. may occur. Difficulties were met at the lower rates until the subject was taken in hand recently by the laboratories of the British Scientific Instrument Research Association at Chislehurst, Kent, on behalf of the National Research Development Corporation. A model has been developed which gives a degree of accuracy at the slow rates within 1%.

An ultrasonic flowmeter works on the principle of measuring the phase difference in signals directed simultaneously upstream and down stream: that is, the difference in the rate at which sound will travel along the pipe in opposite directions. For this purpose, little transducers are set in the inner surface of the pipe, angled at 45° up and down across the flow. They present to the liquid in the pipe the same material as the pipe wall or a material specially chosen for its chemical resistance.

The particular value of an ultrasonic meter is that the internal pipe contour is virtually unaffected, as there need be neither obstructions protruding into liquid stream nor moving parts. For this reason, it can be used to measure the flow of highly corrosive fluid or of liquids containing fibrous suspensions. Transducers have been mounted in 2 in. pipes and can easily be set in pipes of diameter up to about 12 in. The laboratories have been asked to install the system in a 5 ft. pipe; and there should be no serious difficulty in fitting it to 30 ft. conduits.

The main reason for choosing ultrasonic wavelengths was to keep the transducers small. In the pipes of small diameter, they measure between ½ in. and 1 in.—*The New Scientist.*

Two Stages in the Tectonic History of the Earth

New data confirming the theory of the radioactive heating of the globe were given by Vladimir Belousov, Corresponding Member of the USSR Academy of Sciences, in a report to the Scientific Council of the Academy's Institute of the Physics of the Earth. He advanced original ideas about the relationship between tectonic processes and the general development of the earth. According to his hypothesis, there were two stages in the tectonic history of the earth: the granite and the basalt. The latter was marked by the rising of large masses of overheated basalts to the surface. It was at that stage, according to Belousov, that the formation of large plateaus, landlocked seas and, lastly, oceans occurred.

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Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

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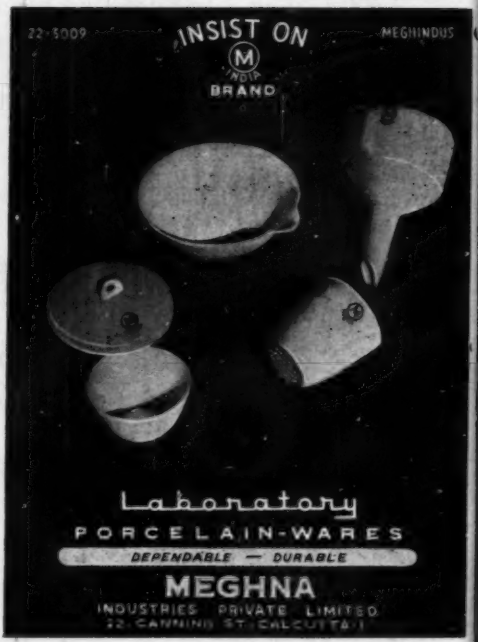

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